California Industrial Existing Construction Energy Efficiency Potential Study

CALMAC Study ID: PGE0252.01

Volume 1 of 2 – Main Report

Final Report to

Pacific Gas and Electric Company
San Francisco, California

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E EXECUTIVE SUMMARY

This study assesses electric and gas energy-efficiency potential in existing industrial facilities within the service territories of the four major investor-owned utilities (IOUs) in California: Pacific Gas and Electric Company (PG&E), Southern California Edison Company (SCE), San Diego Gas and Electric Company, and Southern California Gas (SCG). The study was managed by PG&E, with review and input from the IOUs, the California Public Utilities Commission and the California Energy Commission. The study was funded through the public goods charge for energy efficiency and is available for download at www.calmac.org.

E.1 SCOPE AND APPROACH

In the study, three types of energy-efficiency potential are estimated:

- **Technical potential,** defined as the *complete* penetration of all measures analyzed in applications where they were deemed *technically* feasible from an engineering perspective
- **Economic potential,** defined as the *technical potential* of those energy-efficiency measures that are cost-effective when compared to supply-side alternatives
- **Achievable program potential,** the amount of savings that would occur in response to specific program funding and measure incentive levels.

In addition, naturally occurring energy efficiency impacts are estimated. These are savings that result from normal market forces. Achievable program potential reflects savings that are projected beyond those that would occur naturally in the absence of any market intervention.

The method used for estimating potential is a "bottom-up" approach in which energy efficiency costs and savings are assessed at the customer segment and energy-efficiency measure level. For cost-effective measures [based on the total resource cost (TRC) test], program savings potential is estimated as a function of measure economics, rebate levels, and program marketing and education efforts. The modeling approach was implemented using KEMA's DSM ASSYST™ model. This model allows for efficient integration of large quantities of measure, building, and economic data in the determination of energy efficiency potential.

For this study, three different energy-efficiency funding scenarios were constructed. The first scenario, Base achievable, assumes an approximate continuation of the current program funding levels over the next 12 years, an investment of approximately $40 million per year. The second scenario, Advanced achievable, explores additional program potential that could be obtained if program funding levels were increased by about 70 percent. The third scenario, Maximum achievable, presents a model-based upper bound on achievable program potential, assuming that 100 percent of incremental measure cost is paid by the energy efficiency programs. Program budgets in the scenario are about 170 percent higher than for the Base scenario. We caution that the Maximum achievable scenario reflects an extension of current program-cost/savings relationships and may understate the true costs and/or overstate the energy saving derived from extending programs to hard-to-reach customers. Program energy and peak demand savings, as well as program cost effectiveness, are assessed under these three funding scenarios. Program funding scenarios are summarized in Table E-1.

Table E-1
Scenario Spending During the 2005–2016 Forecast Period
(Average Expenditures Over the 12-Year Analysis Period in Millions of $ per Year)

Funding Scenario	Program Budget Components				% of Measure Cost Paid*
	Administration	Marketing	Incentives	Total	
Electricity					
Base Achievable	$5.2	$12.7	$16.1	$34.0	20%-60%
Advanced Achievable	$7.5	$14.3	$30.1	$51.9	45%-90%
Maximum Achievable	$7.1	$15.9	$54.4	$77.4	100%
Natural Gas					
Base Achievable	$1.3	$1.7	$2.1	$5.1	50%-70%
Advanced Achievable	$3.9	$3.2	$6.8	$14.0	75%-85%
Maximum Achievable	$8.6	$5.7	$14.9	$29.3	100%

* Note: for the Advanced and Maximum achievable scenarios, incentives are ramped up from Base levels over the first three years of the forecast period.

E.2 RESULTS

Estimates of industrial energy efficiency potential for the California IOUs are presented in Table E-2. Technical potential is estimated at 5,485 GWh per year, 755 MW, and 469 million therms (Mth) per year. About 90 percent of the technical potential for electricity was determined to be economically viable, while nearly all of the natural gas measures identified for the study were determined to be economically viable. Under the Base achievable scenario, it is estimated that approximately one-third of the electric economic potential and about 10 percent of the gas economic potential could be achieved over the next 12 years, above what will be attained through naturally occurring processes. Under the Maximum achievable scenario, it is estimated that over 55 percent of the electric economic potential and over 40 percent of the gas economic potential could be achieved over the next 12 years. These Maximum achievable estimates are considerably higher than historic levels and are subject to typical forecast uncertainty when extrapolating beyond current experience. The advanced achievable scenario provides an approximate midpoint between the Base and Maximum scenarios.

Table E-2
Estimated Energy Efficiency Potential—Cumulative Through 2016

Energy Type	Base Use	Energy Efficiency Potentials*					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Electricity - GWh	32,847	5,485	4,973	2,748	2,284	1,706	632
Electricity - MW	4,675	755	657	378	301	216	69
Natural Gas - Mth	3,591	469	468	192	122	47	20

* Note, achievable savings are net savings and do not include naturally occurring savings.

Figures E-1 and E-2 show the projections of achievable potential savings in the IOU service areas for electricity and natural gas, respectively, over the forecast horizon. Potential savings for the Base achievable scenario tend to grow steadily over time, while savings for the Advanced and Maximum achievable scenarios ramp up from base levels over the first few forecast years and then flatten out towards the latter part of the forecast horizon. The ramp-up reflects the transition to higher rebate and marketing levels, while the flattening out of cumulative impacts reflects increasing measure saturations over time. The Advanced and Maximum achievable scenarios show larger increases over the Base scenario for natural gas versus electricity. This occurs because the electric Base scenario already reflects fairly high levels of program activity in response to the increased electricity resource requirements.

Figure E-1
Achievable Energy Savings Potential by Program Funding Scenario

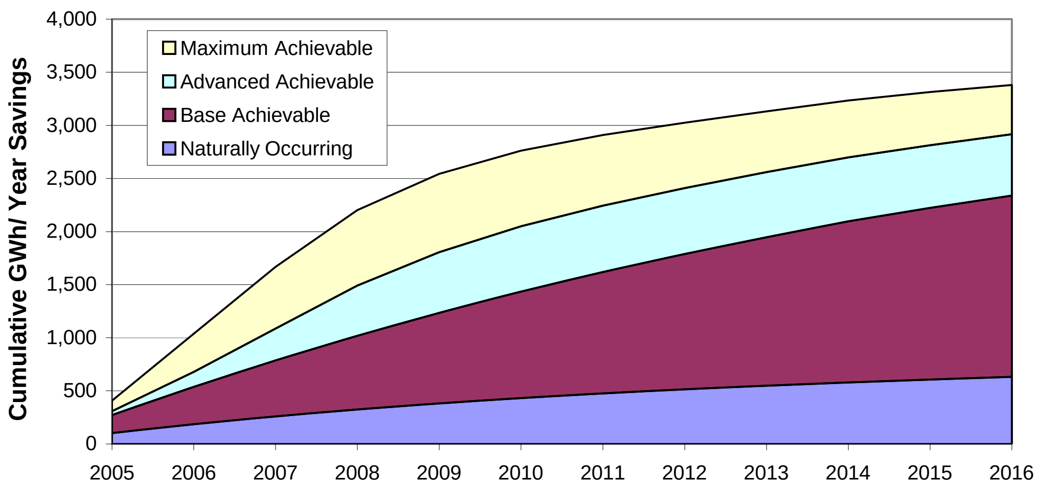
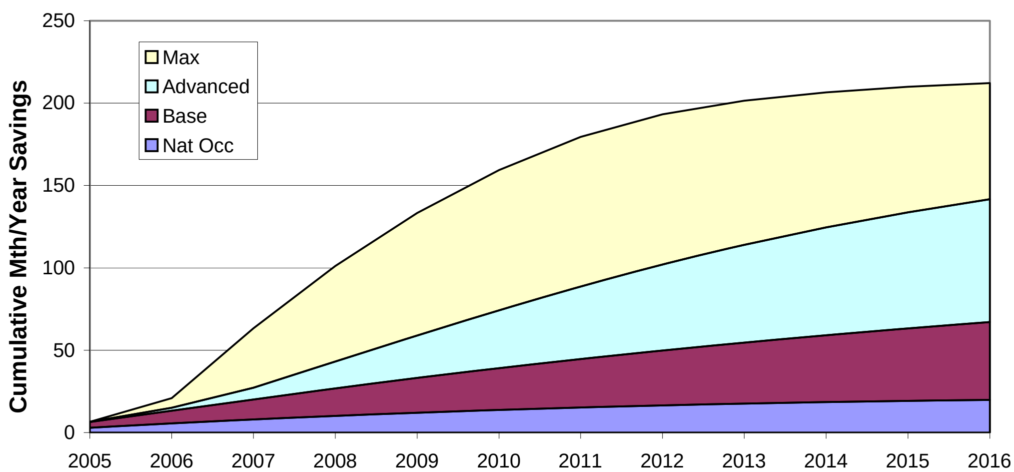
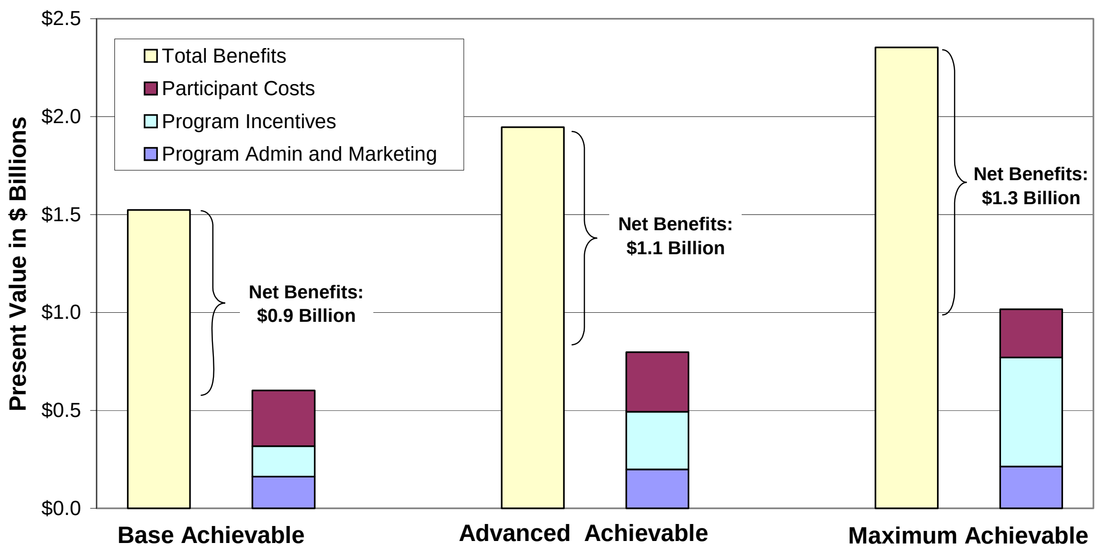


Figure E-2
Achievable Natural Gas Savings Potential by Program Funding Scenario



The costs and benefits associated with the industrial efficiency funding scenarios over the 12-year period are shown in Figures E-3 (electric) and E-4 (natural gas). As shown in Figure E-3, total electric program costs vary from $0.6 billion under the Base achievable scenario, to $0.8 billion under the Advanced achievable scenario to $1.0 billion under the Maximum achievable scenario. Total electric avoided-cost benefits range from $1.5 billion under Base achievable to $2.3 billion under Maximum achievable. Net avoided-cost benefits, which are the difference between total avoided-cost benefits and TRCs (which include participants' costs), range from $0.9 billion to $1.3 billion.

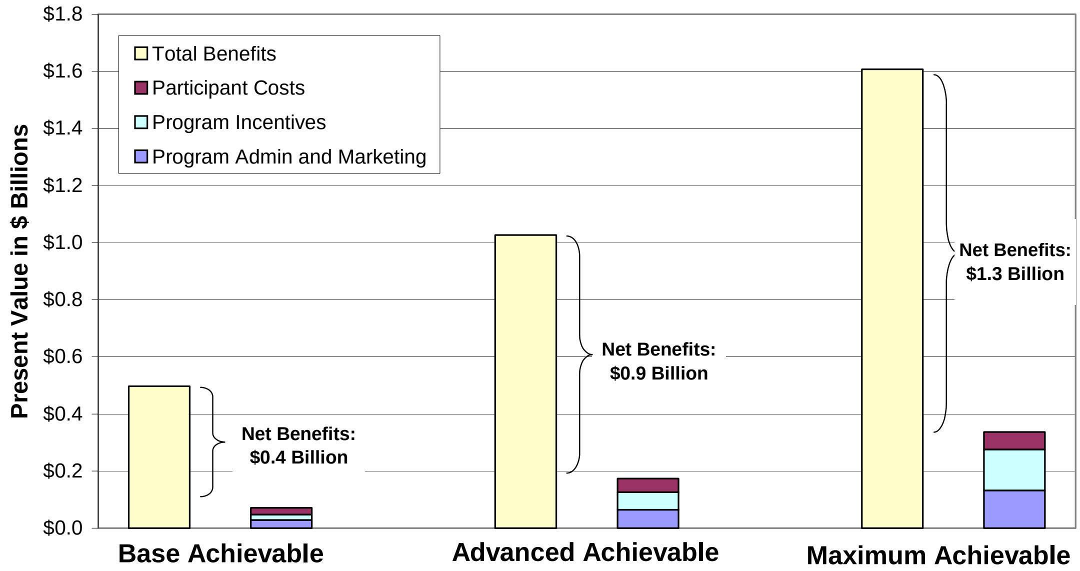
Figure E-3
Costs and Benefits of Industrial Electric Efficiency Savings—2005 to 2016*



*Value of benefits and costs over life of measures, nominal discount rate = 8 percent, inflation rate = 3 percent.

As shown in Figure E-4, total natural gas program costs vary from about $70 million under the Base achievable scenario to about $340 million under Maximum achievable. Total avoided-cost benefits range from about $500 million under Base achievable to $1.6 billion under Maximum achievable. Net avoided-cost benefits range from $400 million to $1.3 billion.

Figure E-4
Costs and Benefits of Industrial Natural Gas Efficiency Savings—2005 to 2016*



*Value of benefits and costs over life of measures, nominal discount rate = 8 percent, inflation rate = 3 percent.

Figure E-5 shows achievable potential estimates by end use. For electricity, the largest savings potential is in pumping systems and lighting. For natural gas, boiler systems and process heating systems are the largest sources of potential.

Figure E-5
Industrial Achievable Savings Potential by End Use—Cumulative to 2016

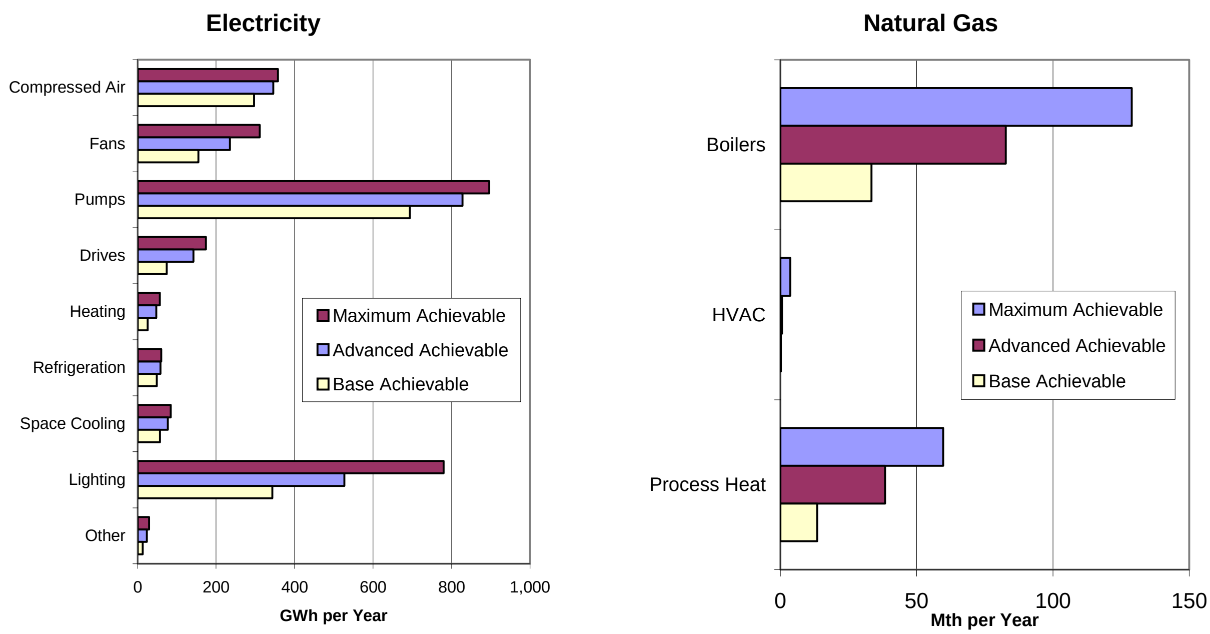
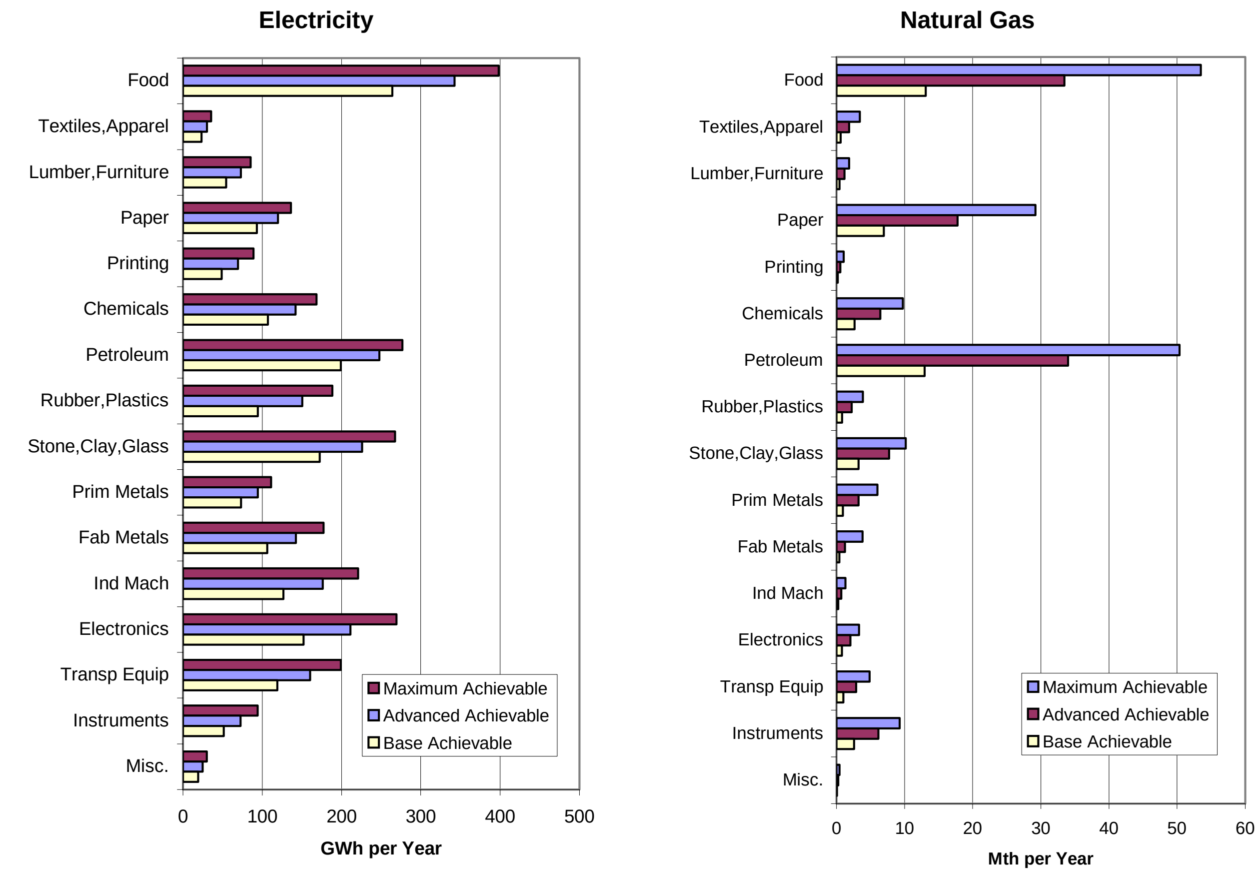


Figure E-6 shows savings potential by industry type. For electricity, food, petroleum, stone, clay and glass, and electronics show some of the higher energy saving potentials. For natural gas, food, petroleum, and paper provide the largest sources of potential under all three achievable scenarios.

Figure E-6
Industrial Achievable Savings Potential by Industry—Cumulative to 2016

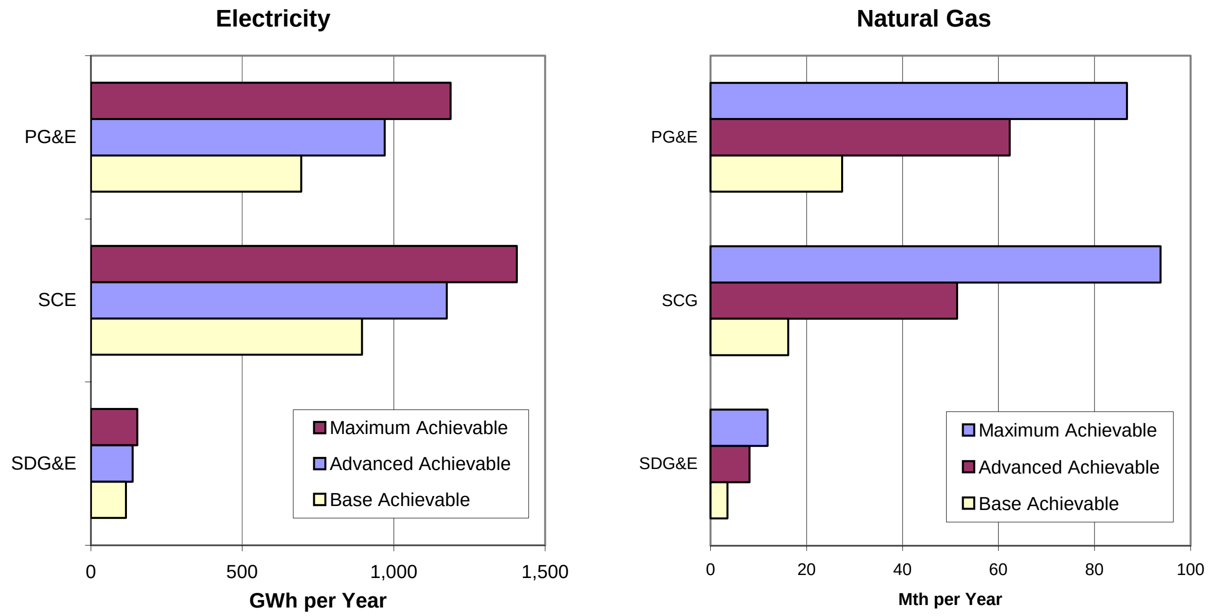


Finally, Figure E-7 provides results by IOU. For electricity, SCE shows the highest potentials, followed closely by PG&E. For natural gas, PG&E shows the highest Base achievable and Advanced achievable savings potential, while SCG is somewhat higher in the Maximum achievable scenario. This result reflects the fact that PG&E's recent industrial program activity has been somewhat higher than SCG's. (More detail on results is presented in Sections 3 and 4.)

E.3 CONCLUSIONS

Over the 2005-2016 period, cumulative achievable energy savings potential in the industrial sector ranges from 5 to 8 percent of current base usage for electricity (demand savings are similar) and from 1 to 5 percent of base usage for natural gas (for the Base, Advanced, and Maximum achievable program scenarios, respectively). The achievable program estimates fall

Figure E-7
Industrial Achievable Savings Potential by IOU—Cumulative to 2016



below economic potential estimates because it is unlikely that programs will be able to capture all the available savings due to factors such as naturally occurring savings, limited equipment turnover during the forecast period, and the fact that some customers will not install cost-effective measures due to various market barriers (such as capital limitations, lack of information about measures, limited installation opportunities due to production schedules, and hassle). All forecast program scenarios have projected TRC ratios greater that 1.0, reflecting our estimates that program benefits will exceed costs.

For electricity, the cumulative energy savings for the Maximum achievable forecast are about 60 percent higher that the Base forecast (that reflects current program efforts) by 2016. For natural gas, the Maximum achievable forecast is about 300 percent above the Base forecast. The differences between electricity and natural gas projections reflect the fact that California has pursued electricity efficiency options more rigorously that it has pursued natural gas options. There is also more uncertainty in the Maximum achievable forecasts, since they reflect program efforts that are considerably beyond historical experience. This is especially true for the natural gas efficiency projections.

For both electricity and natural gas, improved process controls, system optimization, and operation and maintenance measures are key components of potential savings. These measures are likely to be more difficult to implement than strict equipment efficiency improvements, as they will require more customer education to effect improvements. A key component of forecast uncertainty is related to customer adoption of the control and optimization measures.

1 INTRODUCTION

1.1 OVERVIEW

This study assesses electric and gas energy-efficiency potential in existing industrial facilities within the service territories of the four major investor-owned utilities (IOUs) in California: Pacific Gas and Electric Company (PG&E), Southern California Edison Company, San Diego Gas and Electric Company, and Southern California Gas, referred to hereafter as the IOUs. The study was managed by PG&E, with review and input from the IOUs, the California Public Utilities Commission, and the California Energy Commission. The study was funded through the public goods charge for energy efficiency and is available for download at www.calmac.org.

This project is part of a series of studies that have investigated the potential for energy efficiency savings in California to help policy makers and program planners better understand the available energy efficiency resource. An initial industrial energy efficiency market characterization study was completed in 2001 (XENERGY 2001). Other studies, completed in 2002 and 2003, addressed energy efficiency potential in the residential and commercial sectors (XENERGY 2002, XENERGY 2003, and XENERGY 2003a). A summary study for California was prepared in this same timeframe that aggregated the results of the various sector-specific studies (XENERGY 2002a).

In the past 2 years, additional studies have been conducted to update and refine findings from the initial body of work. This report addresses work that was carried out to improve energy efficiency estimates for the industrial sector. Analysis of the residential and commercial sectors was performed by Itron, Inc. and is being documented in a separate report that should be available in the same timeframe as this study.

This report provides both detailed and aggregated estimates of the costs and savings potential of energy-efficiency measures for existing industrial facilities. In addition, it provides forecasts of savings and costs associated with different levels of program funding over a 12-year period (2005-2016).

1.2 APPROACH

The assessment of industrial energy efficiency potential was developed using a bottom-up methodology. For the lighting and HVAC end uses, equipment-specific measures (such as high-efficiency chillers and T8 fluorescent lighting with electronic ballast) were included in the analysis. Costs and savings for these measures, relative to a base technology, were developed and used to determine available savings potential and measure cost effectiveness. For process end uses, measures were more generalized (equipment efficiency improvements, controls, process redesign, etc.) and approximate savings percentages, measure applicability, and cost per unit saved were developed by Lawrence Berkeley National Laboratory (LBNL) based on a compilation of industry-specific secondary-source research.

To aid in the analysis, we utilized the KEMA DSM ASSYST™ model. This model provides a thorough, clear, and transparent documentation database, as well as an efficient data processing system for estimating technical, economic, and achievable potential. Further detail on the DSM ASSYST model is provided in Appendix A.

The assessment is conducted by industry type and by end use. Both crosscutting technologies and industry-specific process measures were examined. Measure penetration into the marketplace is modeled as a function of customer awareness, measure cost effectiveness, and perceived market barriers. Data for the study come from a variety of sources, including: utility billing records from the 2002-2003 period, the Energy Information Association (EIA) 1998 Manufacturing Energy Consumption Survey (MECS), state-sponsored avoided cost studies, energy efficiency program filings, and technology savings and cost data developed through LBNL.

1.3 STUDY SCOPE

As noted above, the study focuses on assessing electric and natural gas energy-efficiency potential in existing industrial facilities within the territories of the major IOUs. This market includes both retrofit and replace-on-burnout measures, and it excludes the new construction market, although the distinction between existing and new construction in the industrial sector is sometimes difficult to determine. The study was limited to the manufacturing sector, which is defined by NAICS (North American Industry Classification System) codes 311 through 339, and Standard Industrial Classification (SIC) codes 20 through 39. An approximate mapping of two-digit SIC codes to three-digit NAICS codes is provided in Appendix B.

The study focuses on assessing potential energy savings from installation of energy-efficiency measures, as these measures are of primary interest to IOU program planners. The study does not address the potential savings from customer behavioral changes, such as increased conservation, as current IOU program offerings focus on energy efficiency, not conservation. While behavioral changes can lead to reductions in energy consumption, as demonstrated by Californians' response to the energy crisis of 2001, it is not clear how permanent and dependable such reductions will be. It is also unclear whether programs promoting conservation measures could make these measures permanent and dependable.

The study is focused on assessing potential savings over the near term, which we define for this report as the next 12 years (2005 through 2016). Consistent with this mid-term focus, the study is restricted to energy-efficiency measures and practices that are presently commercially available. These are the measures that are of most immediate interest to energy-efficiency program planners. The study data, framework, and models can be easily leveraged in the future to add estimates of potential for emerging technologies.

1.4 Report Organization

The remainder of this report is organized as follows:

- Section 2 presents and overview of the methodologies used for this study and describes the program scenarios for which estimates of potential are developed.
- Section 3 presents technical, economic, and achievable potential results for electricity.
- Section 4 presents technical, economic, and achievable potential results for natural gas.
- Section 5 lists the sources used to support this research.

The following appendices are also included in a second report volume:

- Appendix A – Methodology Detail
- Appendix B – Data Development
- Appendix C – Economic Inputs (avoided costs, rates, discount rates)
- Appendix D – Facility and Time-of-Use Inputs (e.g., load shapes)
- Appendix E – Measure Inputs for Electricity
- Appendix F – Measure Inputs for Natural Gas
- Appendix G – Non-Additive Measure-Level Results for Electricity
- Appendix H – Non-Additive Measure-Level Results for Natural Gas
- Appendix I – Achievable Program Scenarios
- Appendix J – Segment and End Use Summary Electric Potentials
- Appendix K – Segment and End Use Summary Natural Gas Potentials

2 METHODS AND SCENARIOS

This section provides a brief overview of the concepts, methods, and scenarios used to conduct this study. Additional methodological details are provided in Appendix A.

2.1 CHARACTERIZING THE ENERGY EFFICIENCY RESOURCE

Energy efficiency has been characterized for some time now as an alternative to energy supply options, such as conventional power plants that produce electricity from fossil or nuclear fuels. In the early 1980s, researchers developed and popularized the use of a conservation supply curve paradigm to characterize the potential costs and benefits of energy conservation and efficiency. Under this framework, technologies or practices that reduced energy use through efficiency were characterized as "liberating 'supply' for other energy demands" and could therefore be thought of as a resource and plotted on an energy supply curve. The energy efficiency resource paradigm argued simply that the more energy efficiency or "nega-watts" produced, the fewer new plants would be needed to meet end users' power demands.[1]

2.1.1 Defining Energy Efficiency Potential

Energy efficiency potential studies were popular throughout the utility industry from the late 1980s through the mid-1990s. (All four of the major California investor-owned utilities commissioned energy efficiency potential studies in the 1990-1992 timeframe.) This period coincided with the advent of what was called least-cost or integrated resource planning. Energy efficiency potential studies became one of the primary means of characterizing the resource availability and value of energy efficiency within the overall resource planning process.

This energy efficiency potential study defines several different *types* of energy efficiency *potential*: namely, technical, economic, achievable program, and naturally occurring. These potentials are shown conceptually in Figure 2-1 and described below.

- **Technical potential** is defined in this study as the *complete* penetration of all measures analyzed in applications where they were deemed *technically* feasible from an *engineering* perspective.
- **Economic potential** refers to the *technical potential* of those energy conservation measures that are cost effective when compared to supply-side alternatives.
- **Achievable program potential** refers to the amount of savings that would occur in response to specific program funding and measure incentive levels. Savings associated with program potential are savings that are projected beyond those that would occur naturally in the absence of any market intervention.

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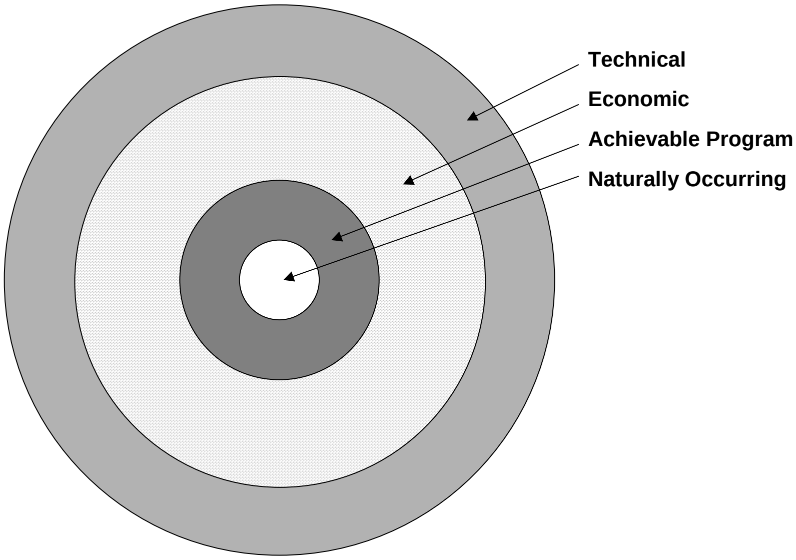
[1] See, for example, (Meier 1982) or (Lovins 1985) for further discussions of energy efficiency as a resource.

- **Naturally occurring potential** refers to the amount of savings estimated to occur as a result of normal market forces; that is, in the absence of any utility or governmental intervention.

Figure 2-1
Conceptual Relationship Among Energy Efficiency Potential Definitions



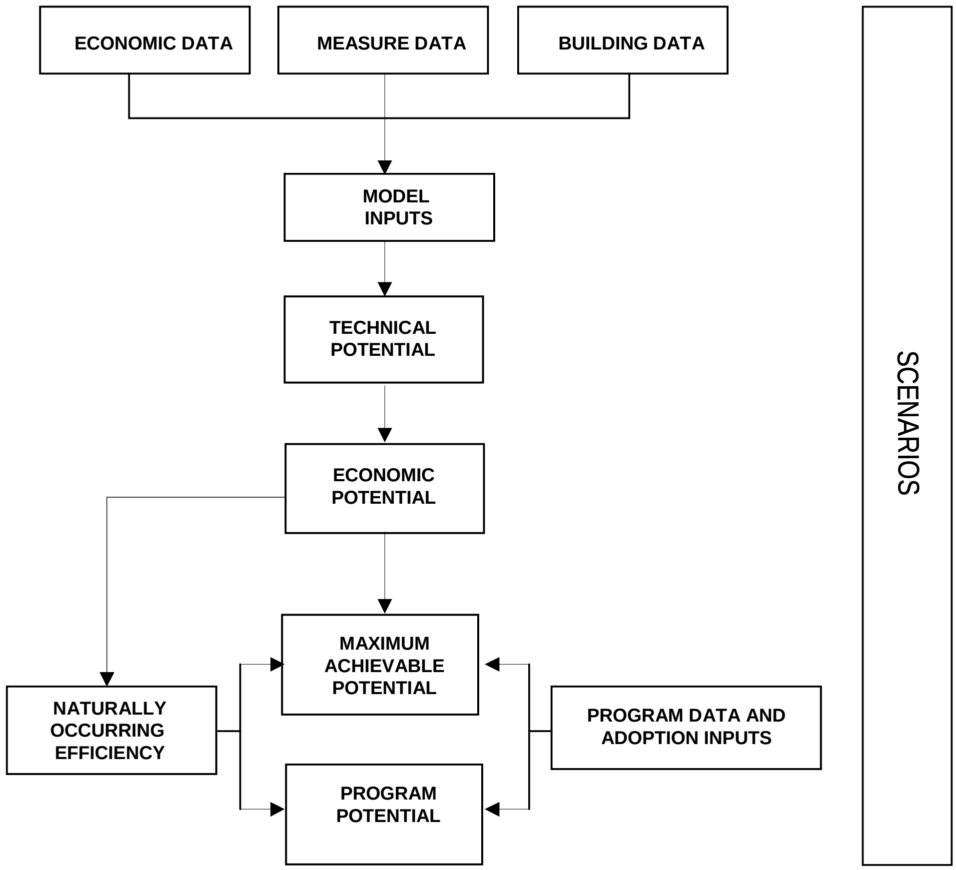
2.2 SUMMARY OF ANALYTICAL STEPS USED IN THIS STUDY

The crux of this study involves carrying out a number of basic analytical steps to produce estimates of the energy efficiency potentials introduced above. The basic analytical steps for this study are shown in relation to one another in Figure 2-2. The bulk of the analytical process for this study was carried out in a model developed by KEMA for conducting energy efficiency potential studies. Details on the steps employed and analyses conducted are described in Appendix A. The model used, DSM ASSYST™, is a Microsoft Excel®-based model that integrates technology-specific engineering and customer behavior data with utility market saturation data, load shapes, rate projections, and marginal costs into an easily updated data management system. The key steps implemented in this study are:

Step 1: Develop Initial Input Data

- Develop a list of energy efficiency measure opportunities to include in scope
- Gather and develop technical data (costs and savings) on efficient measure opportunities. These data were developed by LBNL for this study. (See Appendices E and F.)

Figure 2-2
Conceptual Overview of Study Process



- Gather, analyze, and develop information on facility characteristics, including total square footage or tons of product, electricity consumption and intensity by end use, end-use consumption load patterns by time of day and year (i.e., load shapes), market shares of key electric consuming equipment, and market shares of energy efficiency technologies and practices. (See Appendices B and D.)

Step 2: Estimate Technical Potential and Develop Supply Curves

- Match and integrate data on efficient measures to data on existing facility characteristics to produce estimates of technical potential and energy efficiency supply curves.

Step 3: Estimate Economic Potential

- Gather economic input data, such as current and forecasted retail electric prices and current and forecasted costs of electricity generation, along with estimates of other potential benefits of reducing supply, such as the value of reducing environmental impacts associated with electricity production. Data for this study were developed from an analysis by Energy and Environmental Economics, Inc. (E3 2004). (See Appendices B and C.)

- Match and integrate measure and facility data with economic assumptions to produce indicators of costs from different viewpoints (e.g., societal and consumer).
- Estimate total economic potential.

Step 4: Estimate Achievable Program and Naturally Occurring Potentials

- Screen initial measures for inclusion in the program analysis. This screening may take into account factors such as cost effectiveness, potential market size, non-energy benefits, market barriers, and potentially adverse effects associated with a measure.
- Gather and develop estimates of program costs (e.g., for administration and marketing) and historic program savings.
- Develop estimates of customer adoption of energy efficiency measures as a function of the economic attractiveness of the measures, barriers to their adoption, and the effects of program intervention.
- Estimate achievable program and naturally occurring potentials.

Step 5: Scenario Analyses

- Recalculate potentials under alternate program scenarios.

2.3 PROGRAM SCENARIO ANALYSIS

Scenario analysis is a tool commonly used to structure the uncertainty and examine the robustness of projected outcomes to changes in key underlying assumptions. This section describes the alternative scenarios under which energy efficiency potential is estimated in this study. We developed these scenarios of energy efficiency potential for two key reasons:

1. Our estimates of potential depend on future adoptions of energy efficiency measures that are a function of data inputs and assumptions that are themselves forecasts. For example, our projections depend on estimates of measure availability, measure costs, measure savings, measure saturation levels, retail rates, and avoided costs. Each of the inputs to our analysis is subject to some degree of uncertainty.
2. The ultimate achievable energy efficiency potential depends, by definition, on policy choices, including the level of resources and strategies used to increase measure adoption.

For this study, we focused our scenario analysis around different levels of program funding. The cost components of program funding that vary under each scenario include the following elements:

Marketing Expenditures

- Customers must be aware of efficiency measures and associated benefits in order to adopt those measures. In our analysis, program marketing expenditures are converted to increases in awareness. Thus, under higher levels of marketing expenditures, higher levels of awareness are achieved.

Incentives and Direct Implementation Expenditures

- The higher the percentage of measure costs paid by the program, the higher the participants' benefit-cost ratios and, consequently, the number of measure adoptions.

Administrative Expenditures

- Purely administrative costs, though necessary and important to the program process, do not directly lead to adoptions; however, they have been included in the program funding because they are an input to program benefit-cost tests.

Base Achievable Funding Scenario

Our Base achievable funding scenario is tied to the current California industrial program budget levels. The total incentive dollars were estimated directly in our model as a function of predicted adoptions. What was specified in the model was the percentage of incremental measure cost paid by the program. We attempted to set these percentages at levels similar to the current (2004-2005) efficiency programs. Each nonresidential program (Standard Performance Contracting or SPC, Express Efficiency, etc.) was divided into industrial and commercial components, based on input from utility program planners and managers and judgment.

In the Base scenario, total marketing costs increase by inflation over the analysis period. Program administration costs vary slightly over time as a function of program activity levels. The percent of incremental measure costs paid over time was held constant.

Advanced Achievable Funding Scenario

The Advanced achievable funding scenario was designed to provide an intermediate forecast between the Base and Maximum achievable scenarios. It represents a significant increase in funding from the Base scenario. We increased funding levels by raising both the total marketing expenditures and the per-unit incentive levels. Administration funding levels increased as a function of greater program activity. Overall, we increased program expenditures by about 70 percent in this scenario, with the largest increases occurring for the natural gas programs.

Maximum Achievable Funding Scenario

The Maximum achievable funding scenario sets an upper bound on estimated achievable levels. This funding scenario assumes 100 percent of incremental measure cost is paid by the programs (except of maintenance measures where no incentives are provided). In addition, marketing expenditures are increased considerably in order to inform the entire market about the benefits of the energy efficiency measures. Administration cost levels also increase to support the higher level of program activity.

One should note that in the Maximum achievable scenario, the DSM ASSYST model is being used to predict program levels that are well beyond historical experience. At these very high levels of program activity, it is not clear that the current program expenditure/program savings relationships will be maintained. It is quite possible that program efficiency might decline as the programs extend to the harder-to-reach customers. Hence, the current modeling results, which build upon historic cost/savings relationships, might understate true program costs or overstate true savings for the Maximum achievable scenario.

Summary of Scenarios

Table 2-1 shows average spending for each of the scenarios during the 2005–2016 forecast periods.

Table 2–1
Scenario Spending During the 2005–2016 Forecast Period
(Average Expenditures Over the 12-Year Analysis Period in Millions of $ per Year)

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* Note: for the Advanced and Maximum achievable scenarios, incentives are ramped up from Base levels over the first 3 years of the forecast period.

3 ELECTRIC ENERGY EFFICIENCY POTENTIAL RESULTS

This section presents our estimates of electric technical, economic, and achievable energy-efficiency potential for the industrial sector of the major investor-owned utility (IOU) service territories.

3.1 INTRODUCTION

A total of 127 industrial electric measures were included in the analyses (see Appendix E). The complete set of measures considered was pre-screened to only include those measures that are presently commercially available to provide a realistic assessment of potential. Thus, few emerging technologies were included in the analysis. The measure analysis was segmented into the three electric IOU service territories and, further, into 16 industrial categories based on standard industrial code (SIC) classifications. (The more-recent North American Industrial Classification System, NAICS, was not used because most utility databases were still utilizing the SIC system at the time of the analysis.) As a result, our analyses were conducted for approximately 3,400 measure-market segment applications. (Not all measures applied to every industrial segment.)

The technical, economic, and achievable potential results are presented in several formats:

- In aggregate for each utility
- By end-use and measure
- In the form of energy and demand supply curves.

We provide estimates of savings potential in both absolute and percentage terms. Total base use, from which percentages are calculated, was developed from utility billing data collected in the 2002–2003 time period. For electric consumption, the total base electric use in the major IOU service territories is roughly 33,000 GWh. We estimate that the peak demand associated with total industrial energy for the three utilities is approximately 4,700 MW, based on application of end-use shares and end-use load shapes to the utility billing data.

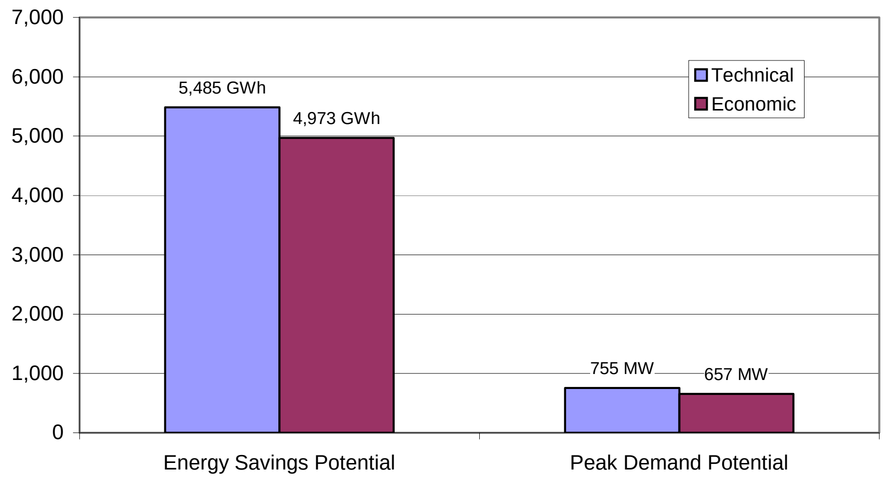
3.2 ELECTRIC TECHNICAL AND ECONOMIC POTENTIAL

Estimates of overall energy efficiency technical and economic potential are discussed in Section 3.2.1. More detail on these potentials is presented in Section 3.2.2. Energy efficiency supply curves are shown in Section 3.2.3.

3.2.1 Aggregate Electric Technical and Economic Savings Potential by Utility

In Figure 3-1, we present our estimates of total electric technical and economic potential for energy and peak demand.

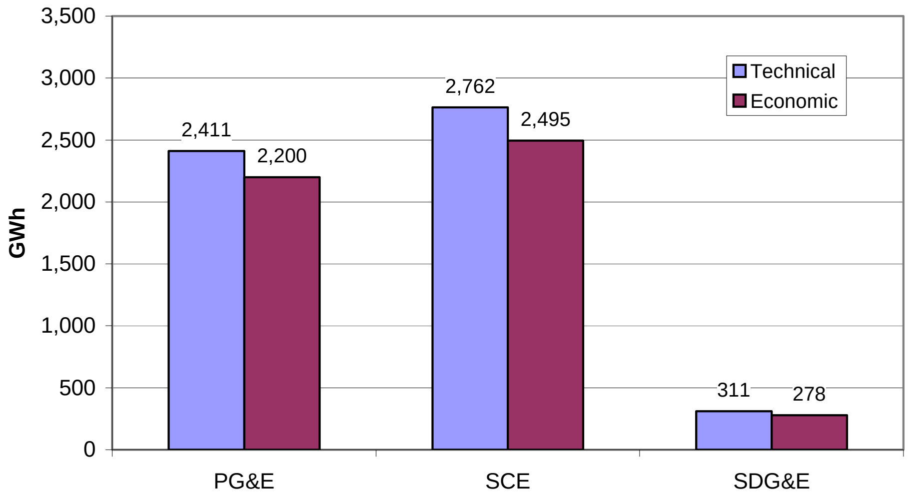
Figure 3-1
Estimated Electric Technical and Economic Potential
(Industrial Sector Existing Construction, PG&E/SCE/SDG&E, 2005)



Figures 3-2 and 3-3 show technical and economic potential by utility. Overall, technical energy savings potential is estimated to be roughly 5,500 GWh, about 17 percent of total industrial electric usage (i.e., 5,485 GWh Savings ÷ 32,847 GWh of base consumption). Economic potential is estimated to be about 5,000 GWh, about 15 percent of total base usage. Technical demand savings potential is estimated to be over 750 MW, about 16 percent of total peak demand. Economic potential is estimated to be approximately 660 MW, about 14 percent of total base demand.

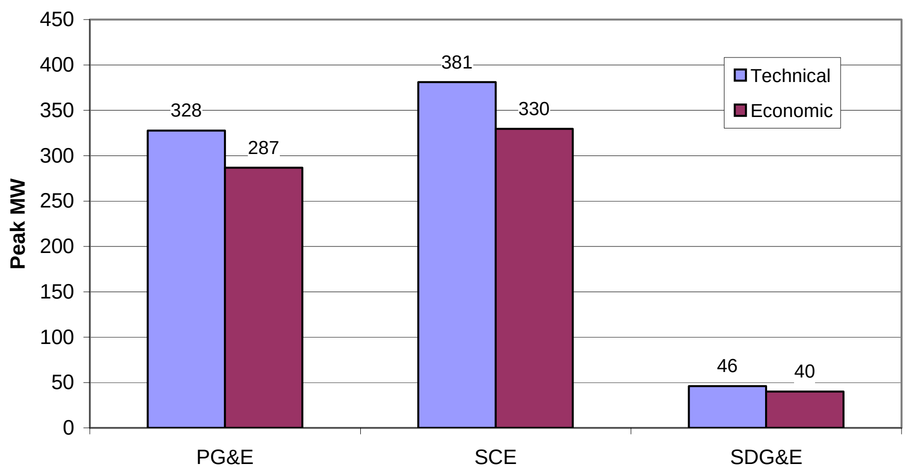
The potentials in the Pacific Gas and Electric (PG&E) and Southern California Edison (SCE) territories are similar in size. SCE has slightly higher economic savings potential at about 2,500 GWh, followed closely by PG&E's potential of approximately 2,200 GWh. As a percent of base consumption, the economic energy savings potentials are 16 percent for PG&E, 15 percent for SCE, and 14 percent for San Diego Gas & Electric (SDG&E). Differences are mainly due to the types of industries and the avoided costs in each service territory.

Figure 3-2
Industrial Electric Savings Potential by Utility, 2005



We estimate technical peak demand savings potential of around 350 MW for both PG&E and SCE and just under 50 MW for SDG&E. PG&E and SCE each have economic peak demand savings potential of approximately 300 MW, while our estimate for SDG&E is approximately 40 MW. We estimate PG&E and SCE economic demand savings potential at about 14 percent each and SDG&E's economic demand savings potential at about 13 percent.

Figure 3-3
Industrial Electric Demand Savings Potential by Utility, 2005



3.2.2 Electric Technical and Economic Savings Potential by End Use and Measure

Estimates of energy and peak demand savings potential are provided by end use in Figures 3-4 and 3-5. The first set of figures provides savings in absolute terms; the second, in terms of the percentage of base case end-use energy or peak demand. Pumping represents the largest end-use savings potential, followed by compressed air and lighting.

Figure 3-4
Industrial Electric Savings Potential by End Use, 2005

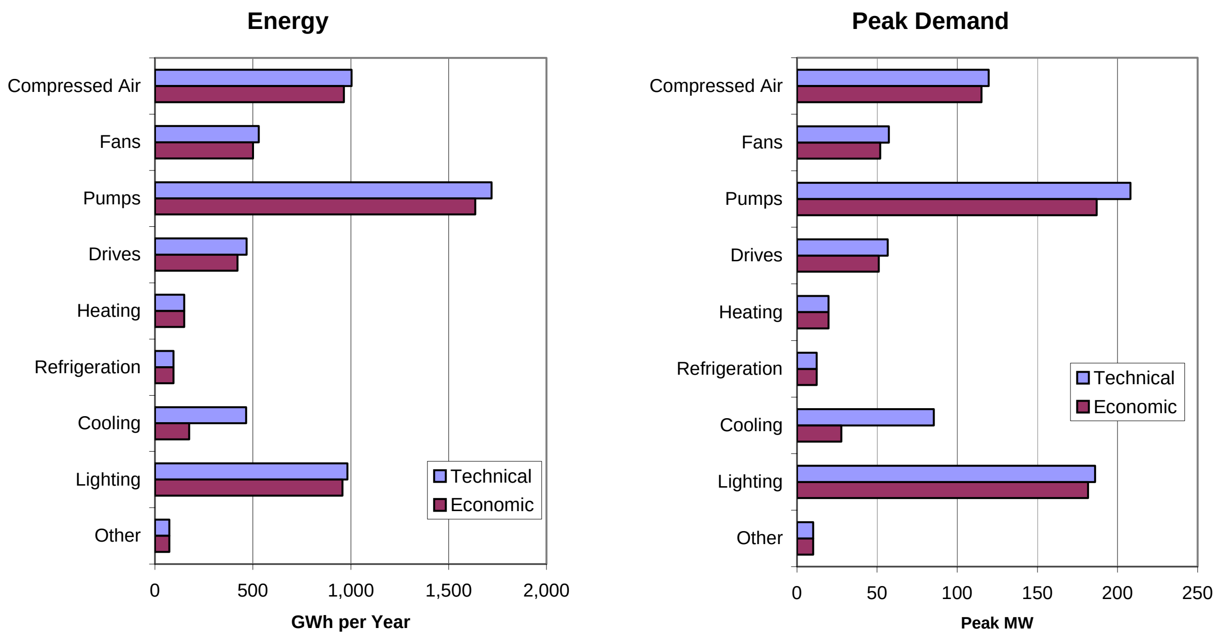
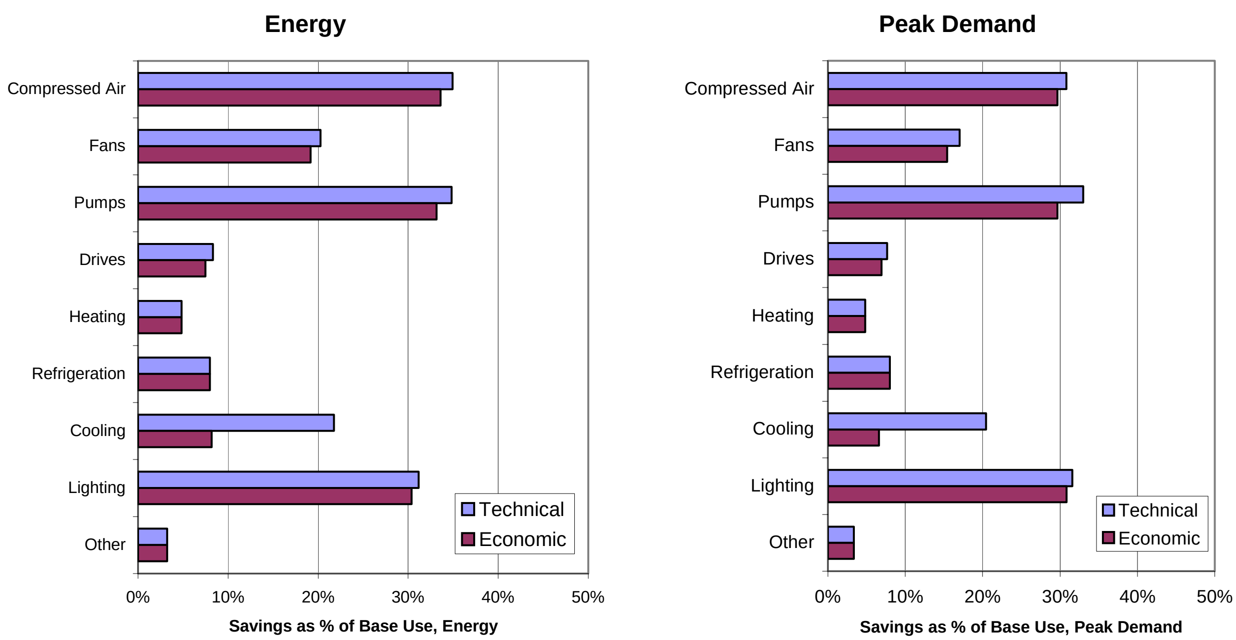


Figure 3-5
Industrial Electric Savings Potential as Percent of Base End-Use Consumption, 2005



Economic savings potential values are summarized by end use and utility in Table 3-1.

Table 3-1
Industrial Electric Economic Savings Potential by End Use and Utility, 2005

	PG&E		SCE		SDG&E		Total	
End Use	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**	**GWh**	**MW**
Compressed Air	446	53	458	55	62	8	966	115
Fans	220	23	260	27	21	2	500	52
Pumps	774	88	794	90	69	9	1,637	187
Drives	148	18	251	31	22	3	421	51
Heating	69	9	73	10	7	1	149	20
Refrigeration	60	8	33	4	1	0.1	94	12
Cooling	67	11	94	15	15	2	175	28
Lighting	393	75	491	93	74	14	958	182
Other	23	3	41	6	8	1	72	10
Total Economic Potential	2,200	287	2,495	330	278	40	4,973	657
Total Electricity Use	14,171	2,002	16,639	2,365	2,037	308	32,847	4,675

Figure 3-6 presents estimates of technical and economic potential by industrial category. Key industrial segments include food, petroleum refining, stone, clay and glass, and industries associated with high technology (industrial machinery, electronics, and transportation equipment).

Note that additional detail on technical, economic, and achievable potential for electricity savings is presented in Appendix H. This appendix shows results by utility, industry segment, and end use.

3.2.3 Electric Energy-Efficiency Supply Curves

Our industrial sector energy-efficiency supply curves are shown in Figures 3-7 and 3-8 for energy and peak demand savings potential, respectively. The curves are shown in terms of savings as a percentage of total industrial sector energy consumption and peak demand for the three utilities in scope. Note that our economic potential figures presented previously are based on the Total Resource Cost test. Also note that our avoided-cost values include both energy and demand benefits. Thus, our economic potential integrates the value of the savings potentials shown in both the energy and demand supply curve figures.

Table 3-2 shows aggregated energy supply curve values by measure. These results are aggregated across industry types and utilities. Individual segment results can vary significantly from the aggregated average values shown. Detailed economic results for individual measures by market segment are provided in Appendix G, although the results in this appendix are not additive. Supply curve data by utility, similar to that presented in Table 3-2, are provided in Appendix I.

Figure 3-6
Industrial Electric Savings Potential by Industrial Category, 2005

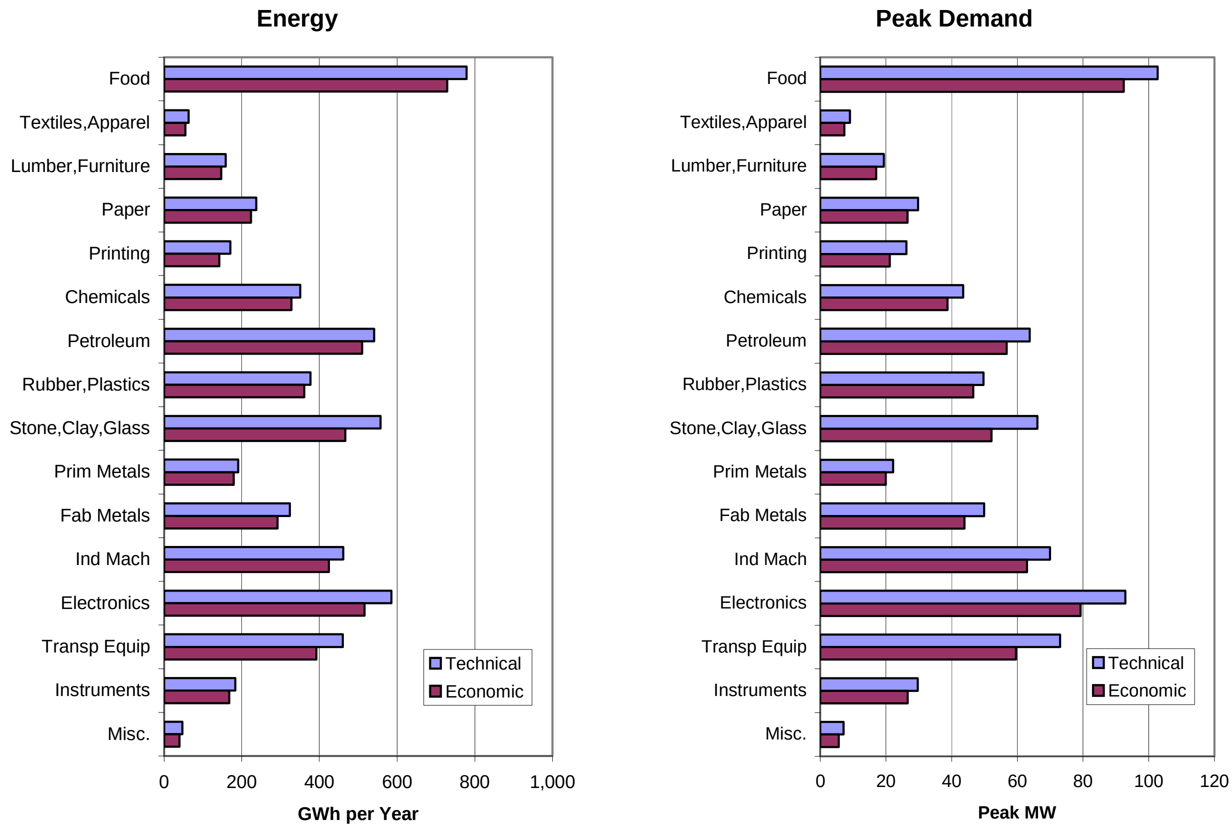
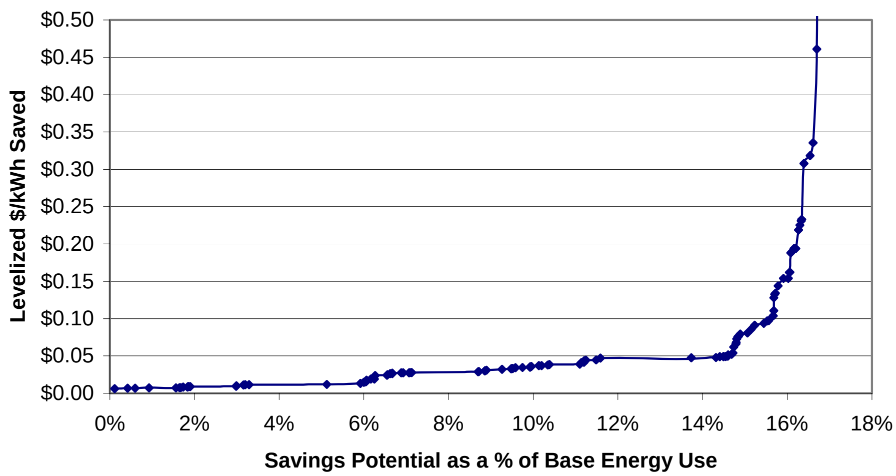
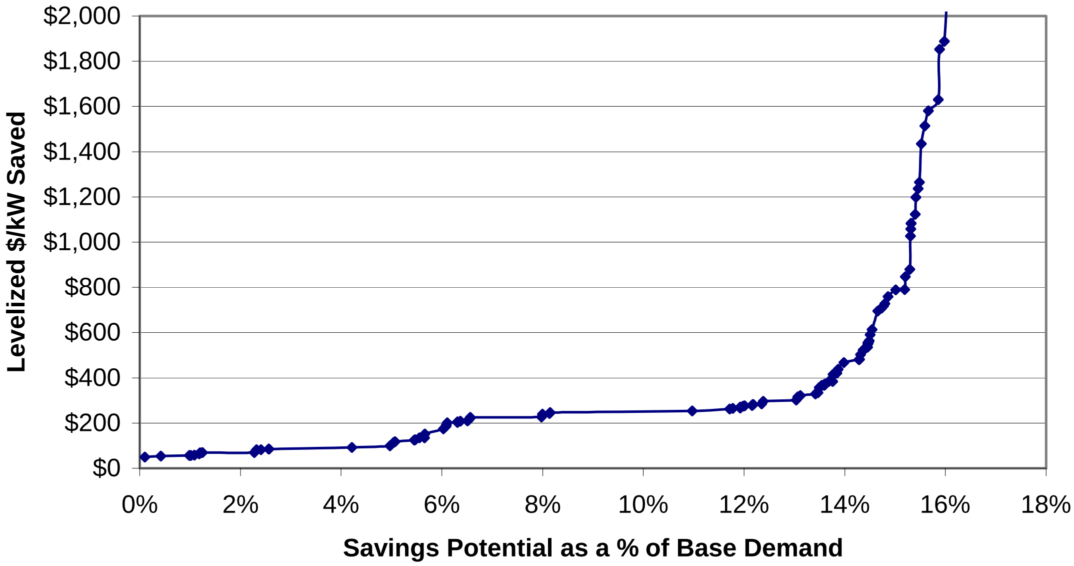


Figure 3-7
Industrial Electric Energy-Efficiency Supply Curve, 2005 – Energy



Note the electric energy efficiency supply curves do not include O&M cost savings that might be associated with some measures. It is not clear that industrial customers fully acknowledge these O&M savings when deciding to adopt these measures.

Figure 3-8
Industrial Electric Energy-Efficiency Supply Curve, 2005 – Demand



Note the electric energy efficiency supply curves do not include O&M cost savings that might be associated with some measures. It is not clear that industrial customers fully acknowledge these O&M savings when deciding to adopt these measures.

Table 3-2
Aggregated Measure Values for Electric Energy-Efficiency Supply Curves, 2005

Energy Supply Curve Measure	GWH Savings	Cumulative GWH Savings	Levelized Energy Cost $/kWH	Cumulative Percent Savings
O&M-Extruders/Injection Molding	38	38	$0.006	0.1%
Pumps - ASD (6-100 hp)	100	138	$0.007	0.4%
Comp Air - ASD (6-100 hp)	58	196	$0.007	0.6%
Compressed Air- Sizing	109	305	$0.007	0.9%
Pumps - O&M	208	513	$0.007	1.6%
Fans - O&M	26	539	$0.007	1.6%
Bakery - Process (Mixing) - O&M	11	550	$0.007	1.7%
Air conveying systems	19	569	$0.008	1.7%
Efficient Refrigeration - Operations	34	603	$0.008	1.8%
High Consistency forming	4	607	$0.009	1.8%
Gap Forming paper machine	4	611	$0.009	1.9%
Efficient Practices printing press	14	625	$0.009	1.9%
Compressed Air-O&M	356	980	$0.009	3.0%
Near Net Shape Casting	2	982	$0.010	3.0%
Bakery - Process	54	1,036	$0.011	3.2%
Heating - Optimize process (M&T)	15	1,051	$0.012	3.2%
Drives - Optimize process (M&T)	30	1,081	$0.012	3.3%
Pumps - Controls	602	1,683	$0.012	5.1%
Compressed Air - System Opt	261	1,944	$0.013	5.9%
Fans- Improve components	27	1,971	$0.015	6.0%
Process control	7	1,978	$0.015	6.0%
Replace V-Belts - Drives	10	1,988	$0.015	6.1%
Top-heating (glass)	4	1,992	$0.018	6.1%
New transformers welding	32	2,024	$0.019	6.2%
Efficient processes (welding, etc.)	27	2,052	$0.019	6.2%
Efficient drives - rolling	7	2,059	$0.024	6.3%

Capacity Supply Curve Measure	MW Savings	Cumulative MW Savings	Levelized Capacity Cost $/kW	Cumulative Percent Savings
O&M - Extruders/Injection Molding	4.7	5	$50	0.1%
Compressed Air- Sizing	14.7	19	$53	0.4%
Pumps - O&M	26.6	46	$57	1.0%
Bakery - Process (Mixing) - O&M	1.4	48	$57	1.0%
Fans - O&M	3.4	51	$57	1.1%
Efficient Refrigeration - Operations	4.4	55	$64	1.2%
High Consistency forming	0.5	56	$68	1.2%
Gap Forming paper machine	0.5	56	$68	1.2%
Efficient Practices printing press	1.8	58	$69	1.2%
Compressed Air-O&M	48.1	106	$69	2.3%
Heating - Optimize process (M&T)	2.2	108	$82	2.3%
Drives - Optimize process (M&T)	4.2	113	$82	2.4%
Bakery - Process	7.1	120	$85	2.6%
Near Net Shape Casting	0.2	120	$85	2.6%
Pumps - Controls	77.1	197	$92	4.2%
Compressed Air - System Opt	35.3	232	$99	5.0%
Fans- Improve components	3.5	236	$115	5.0%
Replace V-Belts	1.3	237	$118	5.1%
Centrifugal Chiller, 0.51 kW/ton	17.9	255	$125	5.5%
Process control	0.9	256	$127	5.5%
Efficient processes (welding, etc.)	3.9	260	$135	5.6%
New transformers welding	4.6	264	$135	5.7%
Top-heating (glass)	0.5	265	$151	5.7%
Pumps - Sizing	17.3	282	$174	6.0%
Machinery	2.3	284	$185	6.1%
Efficient drives	0.3	285	$192	6.1%

Table 3-2
Aggregated Measure Values for Electric Energy-Efficiency Supply Curves, 2005

Energy Supply Curve Measure	GWH Savings	Cumulative GWH Savings	Levelized Energy Cost $/kWH	Cumulative Percent Savings
Centrifugal Chiller, 0.51 kW/ton	92	2,151	$0.024	6.5%
Efficient drives	3	2,154	$0.025	6.6%
Drives - EE motor	22	2,176	$0.026	6.6%
Machinery	16	2,192	$0.026	6.7%
Efficient Machinery	0	2,192	$0.027	6.7%
Compressed Air - Controls	69	2,261	$0.027	6.9%
Refinery Controls	15	2,276	$0.027	6.9%
Prog. Thermostat - DX	46	2,322	$0.028	7.1%
O&M/drives spinning machines	7	2,329	$0.028	7.1%
Fans - ASD (6-100 hp)	13	2,342	$0.028	7.1%
Efficient desalter	0	2,342	$0.028	7.1%
Pumps - System Optimization	516	2,858	$0.029	8.7%
Efficient electric melting	6	2,863	$0.029	8.7%
Energy Star Transformers	45	2,908	$0.030	8.9%
Heating - Scheduling	3	2,912	$0.030	8.9%
Drives - Scheduling	11	2,923	$0.031	8.9%
Pumps - ASD (100+ hp)	121	3,044	$0.032	9.3%
Comp Air - ASD (100+ hp)	69	3,113	$0.033	9.5%
Drives - Process Control	6	3,119	$0.033	9.5%
Heating - Process Control	6	3,125	$0.033	9.5%
Fans - Motor Practices (6-100 HP)	22	3,147	$0.034	9.6%
Extruders/Inject Molding-multipump	54	3,201	$0.034	9.7%
Fans - ASD (100+ hp)	59	3,260	$0.035	9.9%
Membranes for wastewater	0	3,260	$0.035	9.9%
Optimize drying process	11	3,271	$0.036	10.0%
Optimization Refrigeration	58	3,329	$0.037	10.1%
Clean Room - Controls	20	3,350	$0.037	10.2%
Efficient Curing ovens	48	3,398	$0.038	10.3%
Optimization control PM	12	3,410	$0.039	10.4%
Fans - Controls	237	3,646	$0.039	11.1%
Efficient Printing press	12	3,658	$0.041	11.1%
Injection Molding - Impulse Cooling	20	3,678	$0.041	11.2%
Drying (UV/IR)	2	3,679	$0.043	11.2%
Process optimization	5	3,684	$0.043	11.2%
Other Proc Cntls (batch + site)	8	3,692	$0.044	11.2%
Fans - System Optimization	80	3,773	$0.045	11.5%
Window Film - DX	34	3,807	$0.047	11.6%
RET 2L4' Premium T8, 1EB	705	4,511	$0.048	13.7%
CFL Hardwired, Modular 36W	191	4,702	$0.048	14.3%
Pumps - Motor Practices (100+ HP)	30	4,732	$0.049	14.4%
Pumps - Motor Practices (6-100 HP)	29	4,761	$0.049	14.5%
Replace V-belts – Other	0	4,761	$0.050	14.5%
Comp Air-Motor Practices (100+ HP)	17	4,778	$0.050	14.5%
Comp Air-Motor Practices(6-100 HP)	17	4,795	$0.050	14.6%
Process Drives - ASD	2	4,797	$0.051	14.6%
Direct drive Extruders	28	4,825	$0.052	14.7%
Clean Room - New Designs	11	4,835	$0.054	14.7%
Fans - Motor Practices (1-5 HP)	5	4,840	$0.062	14.7%
Injection Molding - Direct drive	17	4,857	$0.066	14.8%
Power recovery	3	4,860	$0.068	14.8%
Heat Pumps - Drying	3	4,863	$0.073	14.8%
Pumps - Motor Practices (1-5 HP)	8	4,871	$0.076	14.8%
Comp Air-Motor Practices (1-5 HP)	4	4,875	$0.076	14.8%
Fans - Replace 100+ HP motor	15	4,890	$0.079	14.9%
Occup Sensor, 4L4' Flr Fixture	56	4,947	$0.081	15.1%
Drives-Proc Cntl (batch + site)	29	4,976	$0.086	15.1%

Capacity Supply Curve Measure	MW Savings	Cumulative MW Savings	Levelized Capacity Cost $/kW	Cumulative Percent Savings
Efficient drives - rolling	0.9	286	$201	6.1%
Compressed Air - Controls	9.3	295	$203	6.3%
Efficient Machinery	0.0	295	$206	6.3%
Drives - EE motor	2.8	298	$208	6.4%
Energy Star Transformers	6.5	304	$209	6.5%
O&M/drives spinning machines	0.9	305	$212	6.5%
Refinery Controls	1.9	307	$222	6.6%
Efficient desalter	0.0	307	$225	6.6%
Pumps - System Optimization	66.0	373	$226	8.0%
Air conveying systems	0.6	374	$240	8.0%
Window Film - DX	6.6	380	$242	8.1%
Efficient electric melting	0.7	381	$247	8.1%
RET 2L4' Premium T8, 1EB	131.7	513	$254	11.0%
CFL Hardwired, Modular 36W	35.0	548	$262	11.7%
Fans - Motor Pract (6-100 HP)	2.8	551	$265	11.8%
Efficient Curing ovens	6.9	557	$266	11.9%
Membranes for wastewater	0.0	557	$271	11.9%
Clean Room - Controls	2.8	560	$274	12.0%
Optimize drying process	1.4	562	$277	12.0%
Extruders/Inject Molding-multipump	6.7	568	$278	12.2%
Drives - Process Control	0.7	569	$282	12.2%
Heating - Process Control	0.7	570	$282	12.2%
Optimization Refrigeration	7.6	577	$285	12.3%
Optimization control PM	1.6	579	$297	12.4%
Fans - Controls	30.5	609	$301	13.0%
Efficient Printing press	1.5	611	$316	13.1%
Fans - Motor Practices (100+ HP)	2.4	613	$322	13.1%
Occup Sensor, 4L4' Flr Fixtures	13.9	627	$329	13.4%
Injection Mould - Impulse Cooling	2.4	630	$334	13.5%
Other Proc Cntl (batch + site)	1.0	631	$357	13.5%
Comp Air-Motor Practices (100+ HP)	2.3	633	$366	13.5%
Comp Air-Motor Practices(6-100 HP)	2.2	635	$366	13.6%
Process optimization	0.6	636	$369	13.6%
Replace V-belts	0.0	636	$372	13.6%
Pumps - Motor Practices (100+ HP)	3.8	640	$384	13.7%
Pumps - Motor Practices (6-100 HP)	3.7	643	$384	13.8%
Process Drives - ASD	0.2	644	$415	13.8%
Direct drive Extruders	3.5	647	$421	13.8%
Clean Room - New Designs	1.3	648	$437	13.9%
Window Film - Chiller	5.3	654	$468	14.0%
DX Packaged System, EER=10.9	13.9	668	$480	14.3%
Fans - Motor Practices (1-5 HP)	0.6	668	$481	14.3%
Comp Air - ASD (6-100 hp)	0.8	669	$503	14.3%
Prog. Thermostat - DX	2.4	671	$522	14.4%
Fans - ASD (6-100 hp)	0.7	672	$522	14.4%
Pumps - ASD (6-100 hp)	1.3	673	$530	14.4%
Injection Molding - Direct drive	2.1	676	$535	14.5%
Power recovery	0.3	676	$550	14.5%
Drying (UV/IR)	0.1	676	$555	14.5%
Heat Pumps - Drying	0.4	676	$557	14.5%
Comp Air-Motor Practices (1-5 HP)	0.6	677	$563	14.5%
Pumps - Motor Practices (1-5 HP)	1.0	678	$591	14.5%
Fans - Replace 100+ HP motor	2.0	680	$614	14.5%
Fans - System Optimization	5.2	685	$696	14.7%
Drives-Proc Cntl (batch + site)	3.6	689	$708	14.7%
Comp Air - Replace 100+ HP motor	1.8	691	$718	14.8%

Table 3-2
Aggregated Measure Values for Electric Energy-Efficiency Supply Curves, 2005

Energy Supply Curve Measure	GWH Savings	Cumulative GWH Savings	Levelized Energy Cost $/kWH	Cumulative Percent Savings	Capacity Supply Curve Measure	MW Savings	Cumulative MW Savings	Levelized Capacity Cost $/kW	Cumulative Percent Savings
Window Film - Chiller	27	5,003	$0.091	15.2%	Chiller Tune Up/Diagnostics	1.1	692	$728	14.8%
DX Packaged System, EER=10.9	71	5,075	$0.094	15.5%	Pumps - Replace 100+ HP motor	3.0	695	$759	14.9%
Pumps - Replace 100+ HP motor	23	5,098	$0.097	15.5%	Cool Roof - DX	7.3	702	$788	15.0%
Comp Air - Replace 100+ HP motor	14	5,112	$0.097	15.6%	EMS - Chiller	8.2	710	$790	15.2%
Efficient grinding	35	5,147	$0.104	15.7%	Light cylinders	0.7	711	$848	15.2%
Light cylinders	5	5,152	$0.111	15.7%	Efficient grinding	4.1	715	$879	15.3%
Intelligent extruder (DOE)	0	5,152	$0.128	15.7%	Fans - Replace 1-5 HP motor	0.7	716	$1,026	15.3%
Fans - Replace 1-5 HP motor	5	5,157	$0.133	15.7%	Heating - Scheduling	0.1	716	$1,058	15.3%
Fans - Motor Practices (100+ HP)	6	5,163	$0.134	15.7%	Drives - Scheduling	0.3	716	$1,082	15.3%
Pumps - Sizing	21	5,184	$0.144	15.8%	Intelligent extruder (DOE)	0.0	716	$1,083	15.3%
EMS - Chiller	42	5,226	$0.154	15.9%	Cooling Circ. Pumps - VSD	4.0	720	$1,123	15.4%
Cool Roof - DX	38	5,263	$0.154	16.0%	Comp Air - Replace 1-5 HP motor	0.6	721	$1,198	15.4%
Pumps - Replace 1-5 HP motor	8	5,271	$0.162	16.0%	Fans - Replace 6-100 HP motor	2.1	723	$1,236	15.5%
Comp Air - Replace 1-5 HP motor	5	5,276	$0.162	16.1%	Pumps - Replace 1-5 HP motor	1.0	724	$1,265	15.5%
Fans - ASD (1-5 hp)	6	5,282	$0.188	16.1%	Comp Air - Replace 6-100 HP motor	2.0	726	$1,434	15.5%
Pumps - Replace 6-100 HP motor	25	5,307	$0.194	16.2%	Pumps - Replace 6-100 HP motor	3.3	729	$1,515	15.6%
Comp Air - Replace 6-100 HP motor	15	5,322	$0.194	16.2%	Cool Roof - Chiller	3.3	732	$1,581	15.7%
Cooling Circ. Pumps - VSD	21	5,342	$0.219	16.3%	DX Tune Up/ Advanced Diagnostics	9.2	741	$1,630	15.9%
Fans - Replace 6-100 HP motor	12	5,354	$0.225	16.3%	Fans - ASD (100+ hp)	1.1	743	$1,853	15.9%
Pumps - ASD (1-5 hp)	9	5,363	$0.231	16.3%	Metal Halide, 50W	4.4	747	$1,888	16.0%
Comp Air - ASD (1-5 hp)	5	5,368	$0.233	16.3%	Evaporative Pre-Cooler	5.3	752	$2,361	16.1%
Cool Roof - Chiller	17	5,385	$0.308	16.4%	Comp Air - ASD (100+ hp)	0.9	753	$2,420	16.1%
DX Tune Up/ Advanced Diagnostics	47	5,432	$0.318	16.5%	Pumps - ASD (100+ hp)	1.5	755	$2,538	16.1%
Metal Halide, 50W	25	5,457	$0.336	16.6%	Fans - ASD (1-5 hp)	0.1	755	$14,668	16.1%
Evaporative Pre-Cooler	27	5,484	$0.461	16.7%	Comp Air - ASD (1-5 hp)	0.1	755	$17,225	16.1%
Chiller Tune Up/Diagnostics	1	5,485	$0.877	16.7%	Pumps - ASD (1-5 hp)	0.1	755	$18,188	16.1%

Note the electric energy efficiency supply curves do not include O&M cost savings that might be associated with some measures. It is not clear that industrial customers fully acknowledge these O&M savings when deciding to adopt these measures.

3.3 ACHIEVABLE POTENTIAL

In contrast to technical and economic potential estimates, achievable potential estimates take into account market and other factors that affect adoption of efficiency measures. Our method of estimating measure adoption takes into account market barriers and reflects actual consumer- and business-implicit discount rates. This section presents overall results for achievable potential.

Achievable potential refers to the amount of savings that would occur in response to one or more specific program interventions. Net savings associated with program potential are savings that are projected beyond those that would occur naturally in the absence of any market intervention. Because achievable potential depends on the type and degree of intervention applied, we developed potential estimates under alternative funding scenarios: Base achievable, Advanced achievable, and Maximum achievable.

The Base achievable funding scenario reflects funding levels similar to 2004–2005 program budgets. The Maximum achievable scenario reflects large increases in marketing/information budgets (see Section 2 for details) and an increase of rebates levels to 100 percent of incremental measure costs. The Advanced achievable scenario represents funding levels that are in between the Base and Maximum achievable scenarios. Program energy and peak-demand savings were forecasted under each scenario for the 2005–2016 period. Again, note that the Maximum achievable scenario reflects an extension of current program-cost/savings relationships, and may understate the true costs and/or overstate the energy saving derived from extending programs to the hard-to-reach customers.

Figures 3-9 and 3-10 show estimates of achievable potential savings for energy and peak demand, respectively. These figures also show naturally occurring savings estimates. By 2006, the naturally occurring component of savings is estimated to be about 630 GWh and 70 MW.

As shown in Figure 3-9, by 2016 net energy savings are projected to be roughly 1,700 GWh under Base achievable, 2,300 MW under Advanced achievable, and 2,750 under Maximum achievable. Figure 3-10 depicts projected net peak demand savings of about 220 MW under Base achievable, 300 MW under Advanced achievable, and 380 MW under Maximum achievable.

Figure 3-9
Achievable Energy Savings Potential by Program Funding Scenario

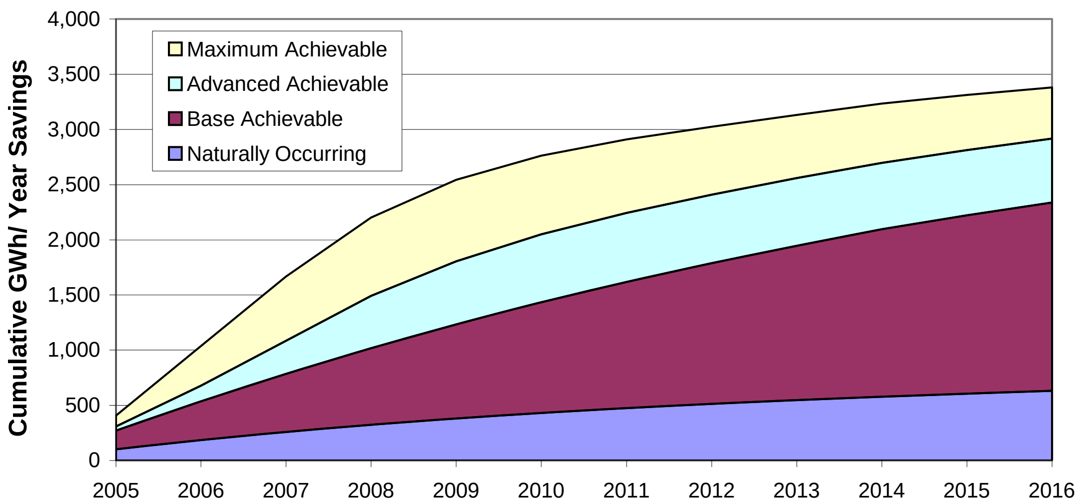
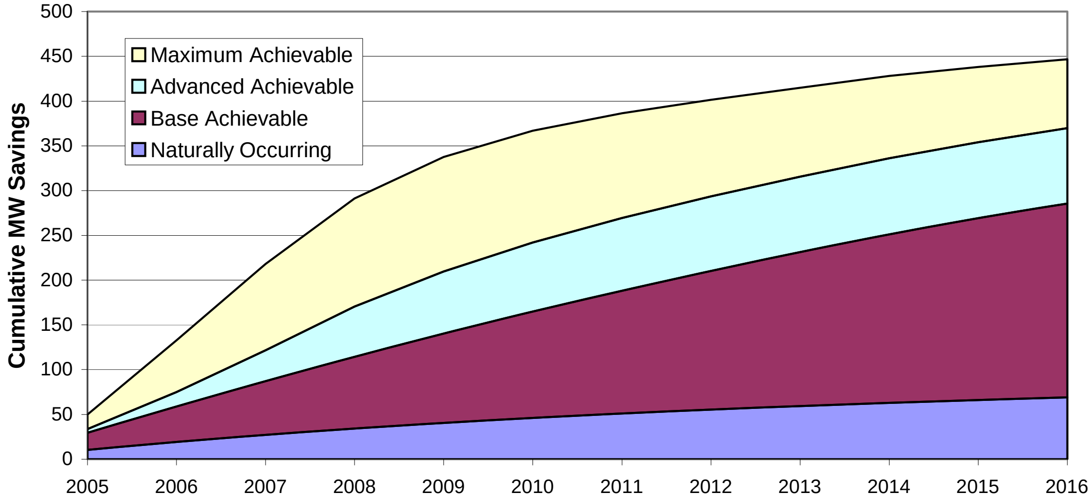
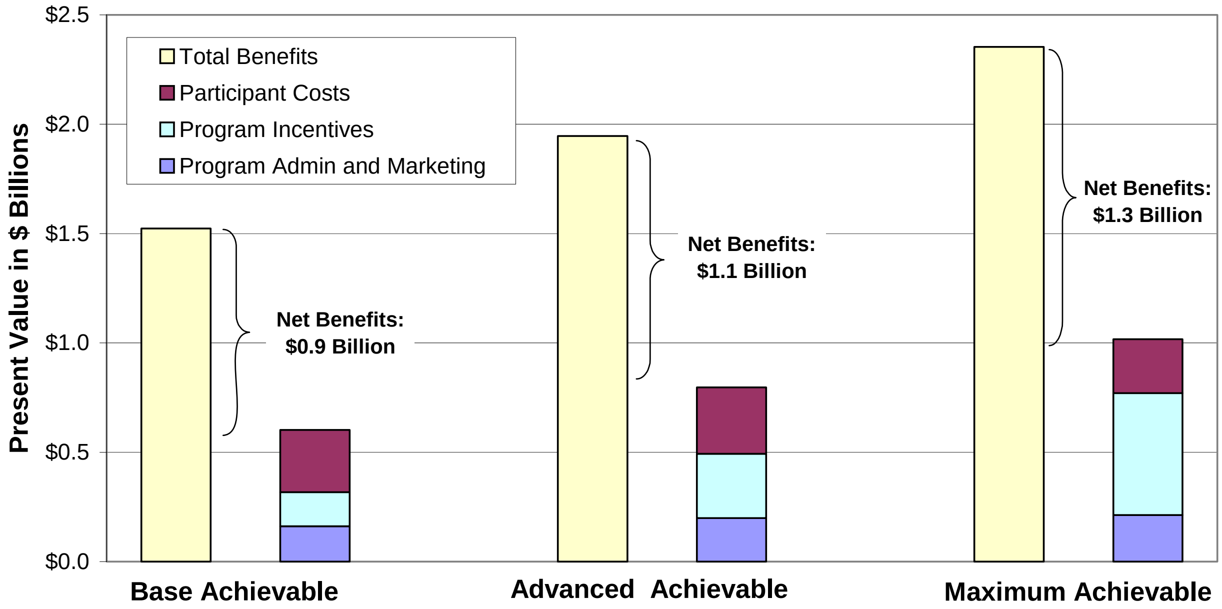


Figure 3-10
Achievable Peak Demand Savings Potential by Program Funding Scenario



The costs and benefits associated with the industrial efficiency funding scenarios over the 2005-2016 forecast period are shown in Figure 3-11. Total program and participant costs vary from $0.6 billion under the Base achievable scenario to $1.0 billion under Maximum achievable scenario. Total avoided-cost benefits range from $1.5 billion under Base achievable to $2.4 billion under Maximum achievable. Net avoided-cost benefits, which are the difference between total avoided-cost benefits and total resource costs (which include participants' costs), range from $0.9 billion to $1.3 billion. All of the funding scenarios are cost effective based on the TRC test, which is the principal test used in California to determine program cost effectiveness.

Figure 3-11
Costs and Benefits of Industrial Electric Efficiency Savings—2005 to 2016*



*Value of benefits and costs over life of measures, nominal discount rate = 8 percent, inflation rate = 3 percent.

TRC test and other results are summarized in Table 3-3 for all scenario runs. The results shown indicate that all the scenarios are cost effective based on the TRC. TRC values range from a high of 2.5 under the Base achievable scenario to a low of 2.3 under the Maximum achievable scenario.

Table 3-3
Summary of Industrial Electric 12-Year Net Program Potential Results*

Result	Base Achievable	Advanced Achievable	Maximum Achievable
Program Costs (Mil.)	$317	$493	$770
Participant Costs (Mil.)	$285	$305	$247
Avoided Cost Benefits (Mil.)	$1,523	$1,946	$2,353
Net Benefits (Mil.)	$921	$1,149	$1,336
Net Savings	1,706 GWh/Yr 216 MW	2,284 GWh/Yr 301 MW	2,748 GWh/Yr 378 MW
Program TRC Ratio	2.5	2.4	2.3

*All costs, energy and demand savings are cumulative amounts through year 2016. Program TRC is for the entire 2005-2016 forecast period. Present value of benefits and costs over 20-year normalized measure lives for 12 program years (2005-2016), nominal discount rate = 8 percent, inflation rate = 3 percent.

The TRC values remain relatively flat across funding levels due to offsetting factors. First TRC values tend to decrease somewhat as funding levels increase because savings are acquired from measures that are of decreasing cost effectiveness. That is, under the higher funding levels, energy-efficiency opportunities are being purchased from higher on the energy-efficiency supply curve. Countering this trend is the fact that the proportion of net savings increases under the more aggressive scenarios. This is because naturally occurring savings are static across funding levels (since they are by definition unaffected by market interventions) while gross program savings increase substantially; thus, the ratio of net-to-gross savings increases across the more aggressive funding levels.

3.3.1 Breakdown of Achievable Potential

Figure 3-12 shows achievable potential estimates by utility. The results show *net* cumulative savings estimates through 2016. SCE shows the highest potentials, followed closely by PG&E.

Figure 3-12
Industrial Net Achievable Electric Savings Potential by Utility – Cumulative 2005 to 2016

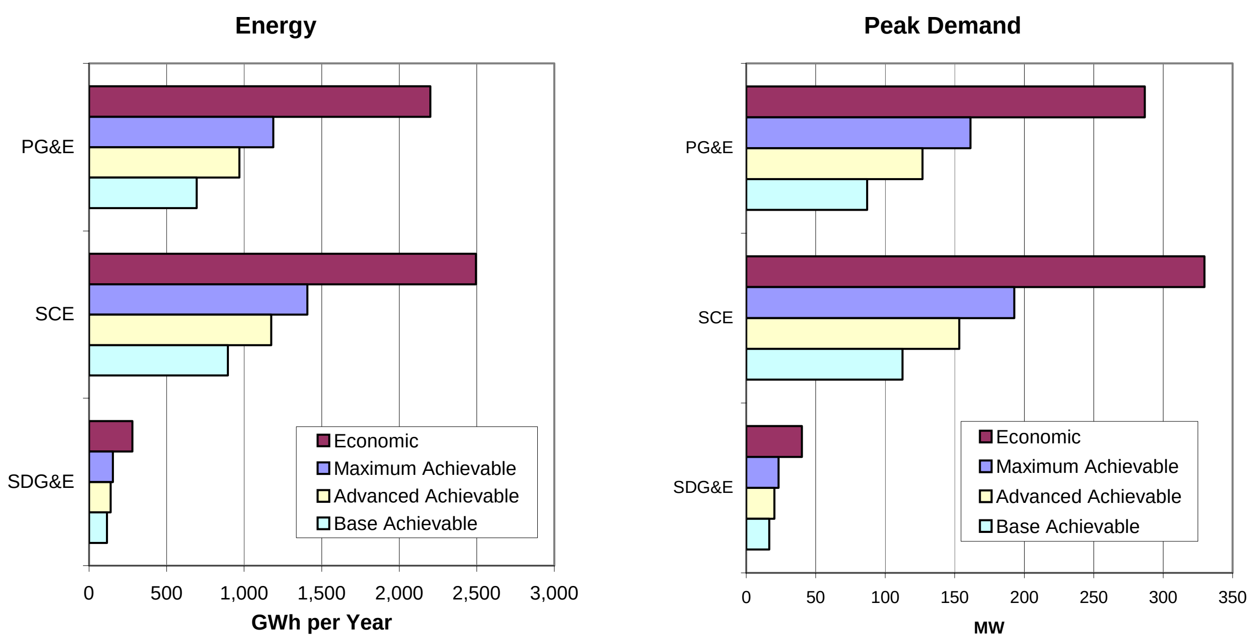
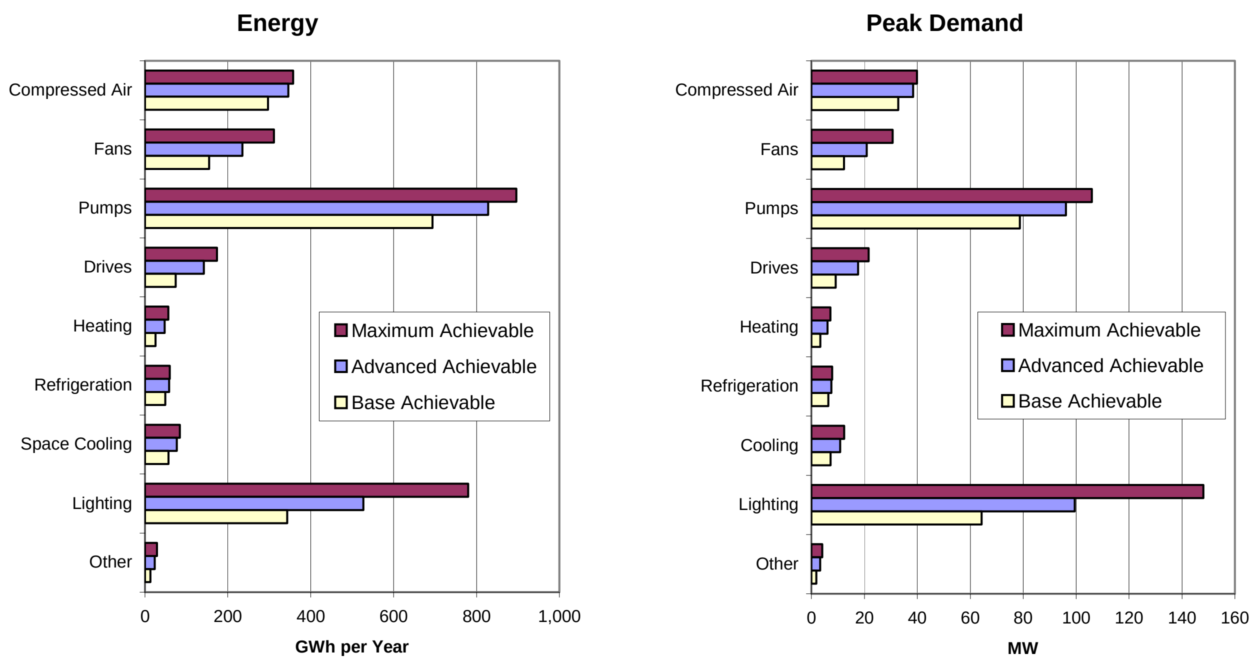


Figure 3-13 shows net achievable potential estimates by end use. Pumping and lighting show the highest potential levels, followed by compressed air and fan systems.

Figure 3-13
Industrial Net Achievable Electric Savings Potential by End Use - Cumulative 2005 to 2016



Net achievable potentials by industry type are shown in Figure 3-14. Food, petroleum, stone, clay and glass, and electronics show some of the higher energy saving potentials. For peak demand, food; petroleum; electronics; transportation equipment; industrial machinery; and stone, clay, and glass show the highest savings potential.

3.3.2 Summary of Potentials

Industrial energy efficiency potential discussed above is summarized in the following tables. Tables 3-4 and 3-5 present energy and peak demand potentials by utility. Tables 3-6 and 3-7 present potentials by end use. Tables 3-8 and 3-9 present potentials by industry. Additional detail on electric potential is presented in Appendix K. This appendix shows technical, economic, and achievable potential by utility, industry segment, and end use.

Figure 3-14
Industrial Achievable Electric Savings Potential by Industry - Cumulative 2005 to 2016

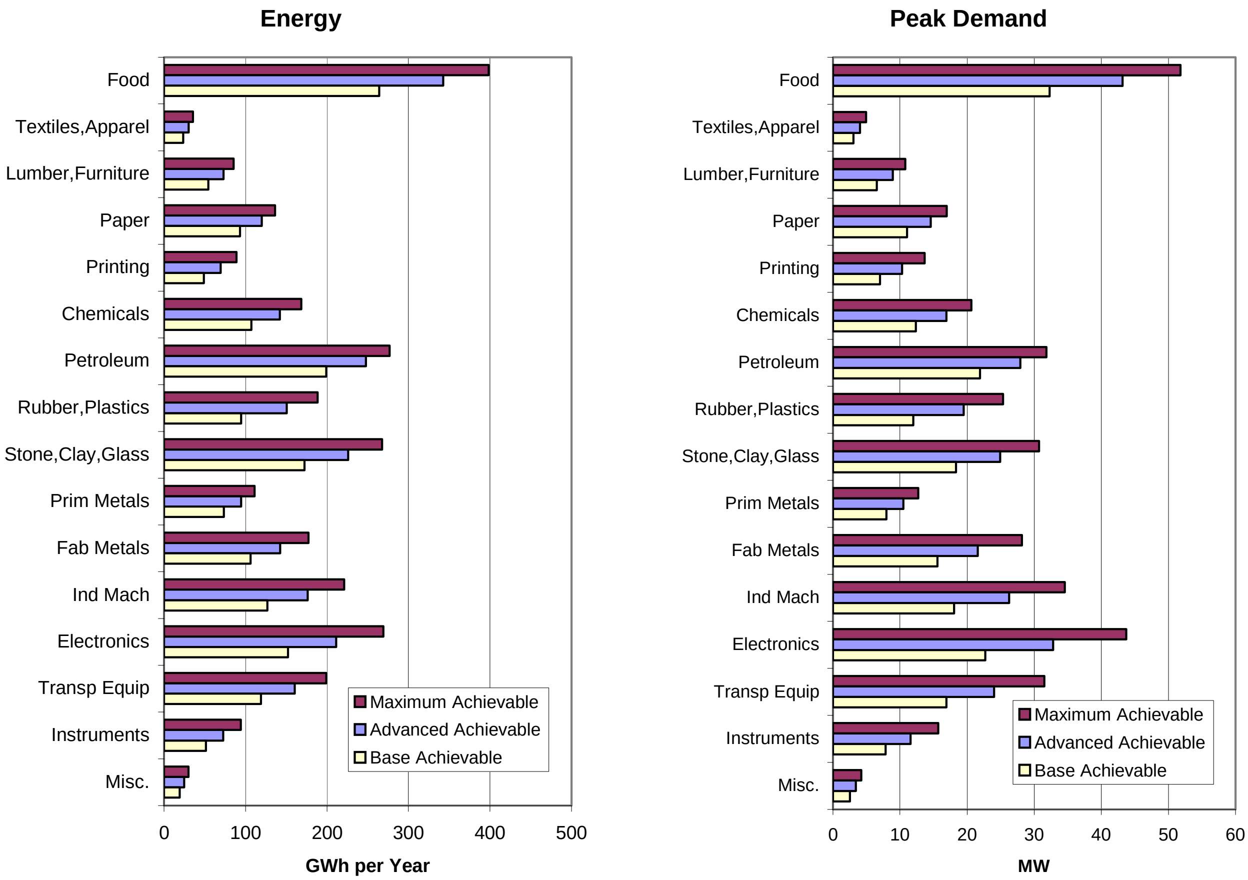


Table 3-4
Summary of Industrial Electric Energy Potentials by Utility – Cumulative 2005 to 2016

Utility	Total GWh Usage	GWh Potentials*					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
PG&E	14,171	2,411	2,200	1,187	970	694	330
SCE	16,639	2,762	2,495	1,407	1,175	896	257
SDG&E	2,037	311	278	154	138	116	45
Total	32,847	5,485	4,973	2,748	2,284	1,706	632

* Note, achievable savings are net savings and do not include naturally occurring savings.

Table 3-5
Summary of Industrial Peak Demand Potentials by Utility—Cumulative 2005 to 2016

Utility	Total MW	MW Potentials*					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
PG&E	2,002	328	287	161	127	87	36
SCE	2,365	381	330	193	153	113	27
SDG&E	308	46	40	23	20	17	6
Total	4,675	755	657	378	301	216	69

* Note, achievable savings are net savings and do not include naturally occurring savings.

Table 3-6
Summary of Industrial Electric Energy Potentials by End Use—Cumulative 2005 to 2016

End Use	Total GWh Usage	GWh Potentials*					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Compressed Air	2,874	1,004	966	358	346	297	184
Fans	2,655	529	500	311	235	154	29
Pumps	5,117	1,719	1,637	896	828	694	261
Drives	6,574	468	421	174	142	74	39
Heating	3,527	149	149	56	47	25	14
Refrigeration	2,722	94	94	60	58	49	12
Space Cooling	3,768	466	175	84	77	57	16
Lighting	3,212	982	958	780	527	343	74
Other	2,397	72	72	29	24	13	2
Total	32,847	5,485	4,973	2,748	2,284	1,706	632

* Note, achievable savings are net savings and do not include naturally occurring savings.

Table 3-7
Summary of Industrial Peak Demand Potentials by End Use—Cumulative 2005 to 2016

End Use	Total MW	MW Potentials*					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Compressed Air	385	120	115	40	38	33	22
Fans	339	57	52	31	21	12	2
Pumps	647	208	187	106	96	79	21
Drives	849	57	51	22	18	9	5
Heating	458	20	20	7	6	3	2
Refrigeration	353	12	12	8	8	6	2
Cooling	728	85	28	12	11	7	1
Lighting	594	186	182	148	99	64	14
Other	319	10	10	4	3	2	0
Total	4,673	755	657	378	301	216	69

* Note, achievable savings are net savings and do not include naturally occurring savings.

Table 3-8
Summary of Industrial Electric Energy Potentials by Industry—Cumulative 2005 to 2016

Industry	Total GWh Usage	GWh Potentials*					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Food	4,495	779	729	398	342	264	100
Textiles, Apparel	462	63	55	36	30	24	7
Lumber, Furniture	987	159	147	86	73	54	19
Paper	1,361	238	224	136	120	93	30
Printing	843	171	142	89	70	49	22
Chemicals	2,987	350	328	168	142	107	37
Petroleum	2,086	541	510	277	248	199	85
Rubber, Plastics	2,232	377	361	188	150	94	25
Stone, Clay, Glass	3,545	557	467	268	226	172	60
Primary Metals	1,186	191	179	111	95	73	23
Fabricated Metals	1,798	324	292	177	142	106	38
Industrial Mach	2,779	461	424	221	176	127	65
Electronics	4,011	585	516	269	211	152	53
Transportation Equip	2,383	460	392	199	160	119	42
Instruments	1,393	183	168	94	73	52	19
Miscellaneous	298	47	39	30	25	19	6
Total	32,847	5,485	4,973	2,748	2,284	1,706	632

* Note, achievable savings are net savings and do not include naturally occurring savings.

Table 3-9
Summary of Industrial Peak Demand Potentials by Industry—Cumulative 2005 to 2016

Industry	Total MW	MW Potentials					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Food	611	103	92	52	43	32	11
Textiles, Apparel	67	9	7	5	4	3	1
Lumber, Furniture	136	19	17	11	9	7	2
Paper	180	30	27	17	15	11	3
Printing	127	26	21	14	10	7	3
Chemicals	390	44	39	21	17	12	3
Petroleum	263	64	57	32	28	22	8
Rubber, Plastics	295	50	47	25	20	12	3
Stone, Clay, Glass	432	66	52	31	25	18	5
Primary Metals	144	22	20	13	11	8	2
Fabricated Metals	280	50	44	28	22	16	5
Industrial Mach	441	70	63	35	26	18	8
Electronics	649	93	79	44	33	23	7
Transportation Equip	383	73	60	32	24	17	5
Instruments	231	30	27	16	12	8	3
Miscellaneous	44	7	6	4	3	3	1
Total	4,673	755	657	377	300	216	69

* Note, achievable savings are net savings and do not include naturally occurring savings.

3.3.3 Differences from the Previous Study

It should be noted that results from this study show industrial energy efficiency potentials that are lower than those previously reported (XENEGY 2002a). For example, this study reports a cumulative Maximum achievable savings of 2,748 GWh for the 12-year forecast period, 2005-2016. This equates to an average increase in savings potential of 229 GWh per year. The previous study showed cumulative Maximum achievable savings of 7,533 GWh over a 10-year forecast period, 2002-2011. This equates to an average increase in savings potential of 753 GWh per year.

Key factors causing differences between the two studies include:

- Program activity in the 2002-2004 period has captured some of the available potential.
- The focus of this study was on the manufacturing sector in the major IOU service territories (PG&E, SCE, and SDG&E). Base energy consumption was estimated to be about 33,000 GWh. The previous study addressed a larger industrial base that included manufacturing, mining, agriculture, and TCU (transportation,

communication, and utilities) for all of California. Base energy consumption for the prior study was estimated at over 83,000 GWh.

- The current study reports customer-level savings potentials while the prior study reported generation-levels savings potentials that include line losses amounting to between 5 percent and 10 percent.
- This study addressed energy savings potential at the industry segment level (the two-digit SIC level/three-digit NAICS level). The prior study only looked at energy savings for two industrial segments: large and small.
- This study utilized a detailed measure list, developed by LBNL, versus a more general aggregated measure list that was utilized for the prior study. (The prior study provided general industrial results that were refined as part of this study.)
  - This study did not assume rebates would be paid for operations and maintenance (O&M) measures while the previous study incorporated O&M measures into aggregate measure packages that were assumed to receive rebates. As a result, the previous study showed more achievable program savings resulting from O&M measures.

Because of the differences noted above, we caution against direct comparison between results of this study and those developed several years ago.

3.4 Summary and Conclusions

For the 2005-2016 period, cumulative achievable electricity savings in the industrial sector range from 5 percent to 8 percent of base usage for the Base, Advanced, and Maximum achievable program scenarios, respectively. The achievable program estimates fall below economic potential estimates because it is unlikely that programs will be able to capture all the available savings due to factors such as naturally occurring savings, limited equipment turnover during the forecast period, and the fact that some customers will not install cost-effective measures due to various market barriers (such as capital limitations, lack of measure information, limited installation opportunities due to production schedules, and hassle).

The cumulative energy savings for the Maximum achievable forecast are about 60 percent higher that the Base forecast (that reflects current program efforts) by 2016. There is more uncertainty in the maximum achievable forecasts since they reflect program efforts that are considerably beyond historical experience.

Improved process controls, system optimization, and O&M measures are key components of potential savings. These measures are likely to be more difficult to implement than strict equipment efficiency improvements as they will require more customer education to effect improvements.

4 NATURAL GAS ENERGY EFFICIENCY POTENTIAL RESULTS

This section presents our estimates of natural gas technical, economic, and achievable energy-efficiency potential for the industrial sector of the major investor-owned utility (IOU) service territories.

4.1 INTRODUCTION

A total of 36 industrial natural gas measures were included in the analyses (see Appendix F). The complete set of measures considered was pre-screened to only include those measures that are presently commercially available to provide a realistic assessment of potential. Thus, few emerging technologies were included in the analysis. The measure analysis was segmented into the 3 natural gas IOU service territories and, further, into 19 industrial categories based on standard industrial code (SIC) classifications. (The more recent North American Industrial Classification System, NAICS, was not used because most utility databases were still using the SIC system at the time of the analysis.) As a result, our analyses were conducted for approximately 1,350 measure-market segment applications. (Not all measures applied to every industrial segment.)

The technical, economic, and achievable potential results are presented in several formats:

- In aggregate for each utility
- By end-use and measure
- In the form of energy and demand supply curves.

We provide estimates of savings potential in both absolute and percentage terms. Total base use, from which percentages are calculated, was developed from utility billing data collected in the 2002–2003 time period. For natural gas consumption, the total base use in the major IOU service territories is roughly 3,600 million therms (Mth).

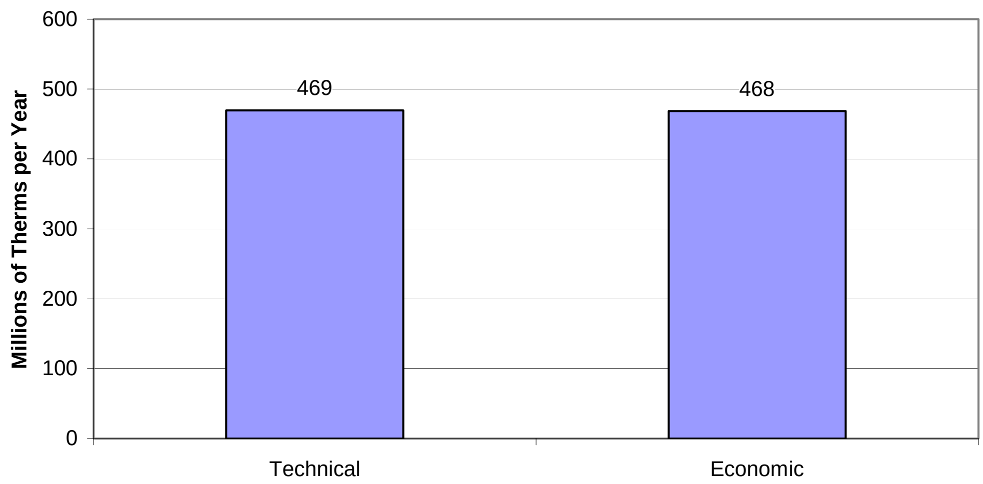
4.2 NATURAL GAS TECHNICAL AND ECONOMIC POTENTIAL

Estimates of overall energy efficiency technical and economic potential are discussed in Section 4.2.1. More detail on these potentials is presented in Section 4.2.2. Energy efficiency supply curves are shown in Section 4.2.3.

4.2.1 Aggregate Natural Gas Technical and Economic Savings Potential by Utility

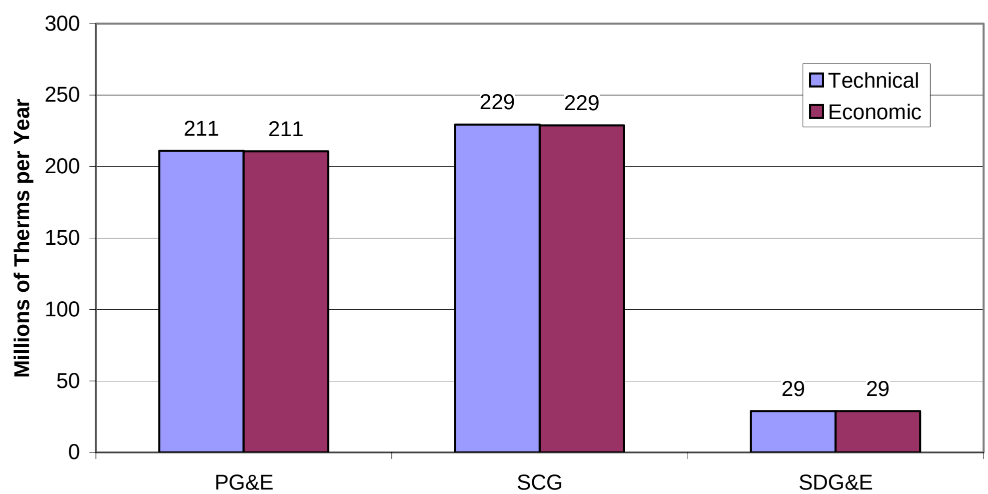
In Figure 4-1, we present our estimates of total technical and economic potential for natural gas savings. Note that technical potential and economic potential are nearly the same, due to a measure list that focused on reasonably cost-effective measures. Overall, technical savings potential is estimated to be roughly 470 Mth, about 13 percent of total industrial natural gas usage, excluding gas used as feed stocks (i.e., 470 Mth Savings ÷ 32,847 Mth of base consumption). Economic potential is also estimated to be about 470 Mth.

Figure 4-1
Estimated Natural Gas Technical and Economic Potential
(Industrial Sector Existing Construction, PG&E/SCG/SDG&E, 2005)



Figures 4-2 shows technical and economic potential by utility. The potentials in the Pacific Gas and Electric (PG&E) and Southern California Gas (SCG) territories are similar in size. SCG has slightly higher economic savings potential at about 230 Mth, followed closely by PG&E's potential of approximately 210 Mth. As a percent of base consumption, the economic energy savings potentials are 14 percent for SDG&E and about 13 percent for PG&E and SCG. Differences are mainly due to the types of industries and the avoided costs in each service territory.

Figure 4-2
Industrial Natural Gas Savings Potential by Utility, 2005



4.2.2 Natural Gas Technical and Economic Savings Potential by End Use & Measure

Estimates of natural gas savings potential are provided by end use in Figures 4-3 and 4-4. The first figure provides savings in absolute terms; the second, in terms of the percentage of base case end-use natural gas consumption. Boilers represent the largest source of savings potential, followed by process heating.

Figure 4-3
Industrial Natural Gas Savings Potential by End Use, 2005

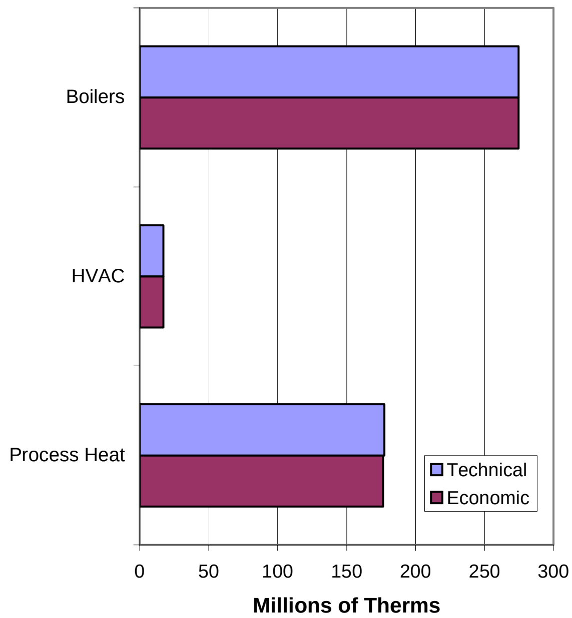
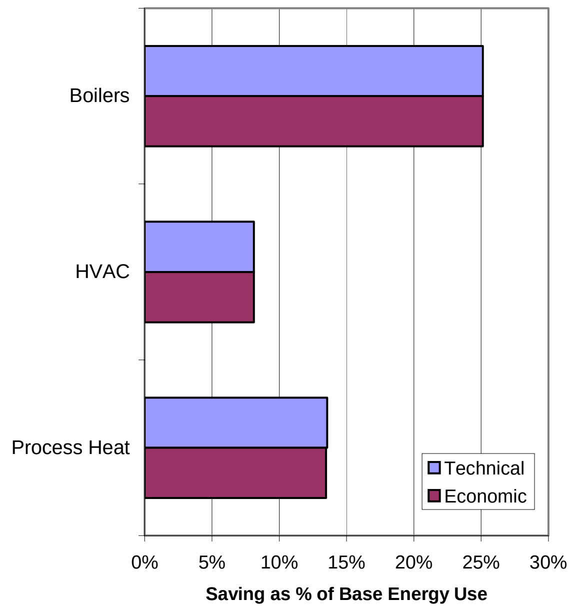


Figure 4-4
Industrial Natural Gas Savings Potential as Percent of Base End-Use Consumption, 2005



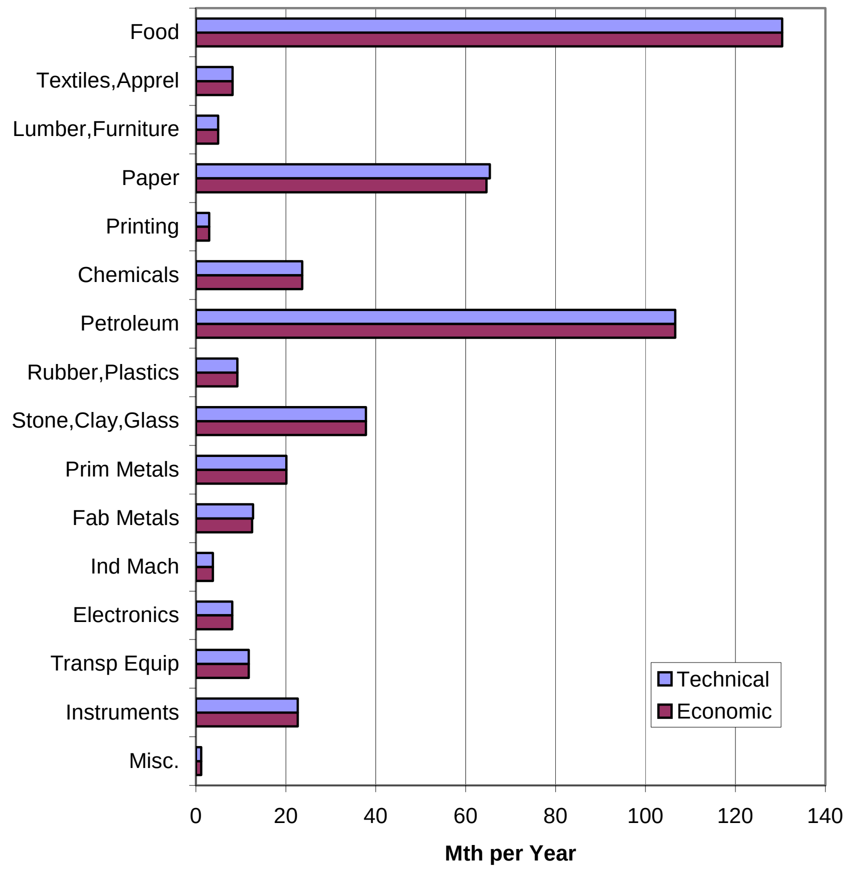
Economic savings potential values are summarized by end use and utility in Table 4-1.

Table 4-1
Industrial Natural Gas Economic Savings Potential by End Use and Utility—Mth, 2005

End Use	PG&E	SCG	SDG&E
Boilers	119	138	18
HVAC	5	7	4
Process Heat	87	83	7
Total Economic Potential	**211**	**229**	**29**
Total Natural Gas Use	1,664	1,718	209

Figure 4-5 presents estimates of technical and economic potential by industrial category. Key industrial segments include food, paper, and petroleum refining.

Figure 4-5
Industrial Natural Gas Savings Potential by Industrial Category, 2005



4.2.3 Natural Gas Energy-Efficiency Supply Curve

Our industrial sector natural gas energy-efficiency supply curve is shown in Figures 4-6. The curve is shown in terms of savings as a percentage of total industrial sector energy consumption for the three utilities in scope.

Figure 4-6
Industrial Natural Gas Energy-Efficiency Supply Curve, 2005

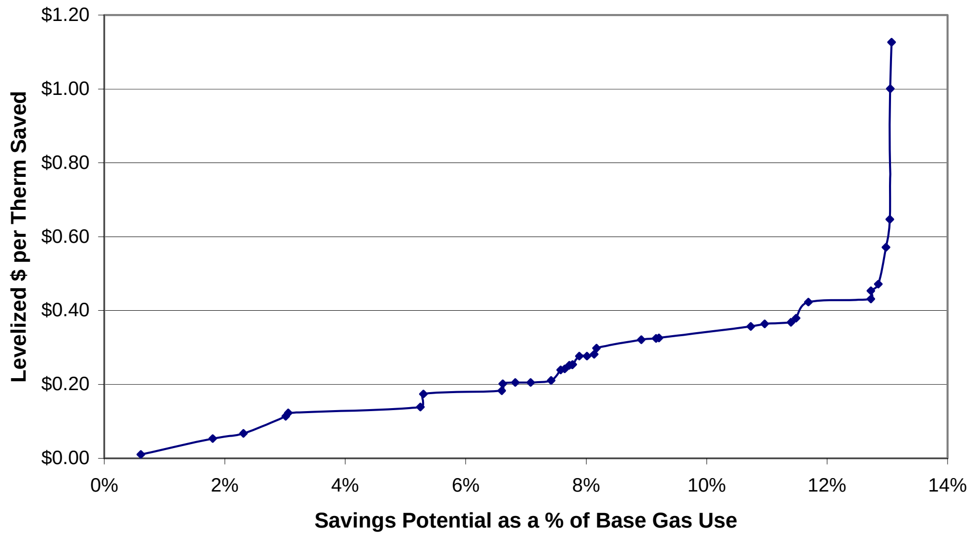


Table 4-2 shows aggregated energy supply curve values by measure. These results are aggregated across industry types and utilities. Individual industrial segment results can vary significantly from the aggregated average values shown. Detailed economic results for individual measures by market segment are provided in Appendix H, although the results in this appendix are not additive. Supply curve data by utility, similar to that presented in Table 4-2, are provided in Appendix I.

Table 4-2
Aggregated Measure Values for Natural Gas Energy-Efficiency Supply Curves, 2005

Energy Supply Curve Measure	Mth Savings	Cumulative Mth Savings	Levelized Capacity Cost $/Therm	Cumulative Percent Savings
Maintain boilers	21.9	21.9	$0.010	0.6%
Load control	42.9	64.7	$0.053	1.8%
Improved process control	18.2	82.9	$0.067	2.3%
Automatic steam trap monitoring	25.3	108.2	$0.114	3.0%
Preventative maintenance	1.5	109.7	$0.123	3.1%
Improved insulation	78.8	188.5	$0.139	5.2%
Condensate return	1.8	190.3	$0.174	5.3%
Process Controls & Management	46.7	237.0	$0.183	6.6%
Duct insulation	0.6	237.6	$0.202	6.6%
Flare gas controls and recovery	7.5	245.1	$0.205	6.8%
Water treatment	9.0	254.1	$0.205	7.1%
Fouling control	12.3	266.4	$0.210	7.4%
High efficiency (95%) condensing furnace/boiler	5.7	272.1	$0.239	7.6%
Combustion controls	2.3	274.4	$0.242	7.6%
Batch cullet preheating	2.8	277.2	$0.252	7.7%
Optimize furnace operations	1.8	279.0	$0.253	7.8%
EMS optimization	0.3	279.3	$0.254	7.8%
Efficient furnaces	4.0	283.2	$0.277	7.9%
Upgrade burner efficiency	4.5	287.7	$0.277	8.0%
Leak repair	4.3	292.0	$0.282	8.1%
Improved separation processes	1.4	293.4	$0.298	8.2%
Efficient burners	26.7	320.1	$0.321	8.9%
Flue gas heat recovery/economizer	8.9	328.9	$0.324	9.2%
Thermal oxidizers	1.7	330.6	$0.326	9.2%
Steam trap maintenance	54.9	385.5	$0.357	10.7%
Oxyfuel	8.3	393.7	$0.364	11.0%
Heat Recovery	15.6	409.3	$0.368	11.4%
EMS install	3.1	412.4	$0.379	11.5%
Improve ceiling insulation	7.3	419.7	$0.423	11.7%
Process integration	37.2	456.9	$0.431	12.7%
Stack heat exchanger	0.1	457.0	$0.454	12.7%
Blowdown steam heat recovery	4.4	461.4	$0.471	12.8%
Efficient drying	4.6	466.0	$0.571	13.0%
Extended nip press	2.4	468.3	$0.647	13.0%
Insulation/reduce heat losses	0.2	468.5	$1.000	13.0%
Closed hood	0.7	469.3	$1.127	13.1%

4.3 ACHIEVABLE POTENTIAL

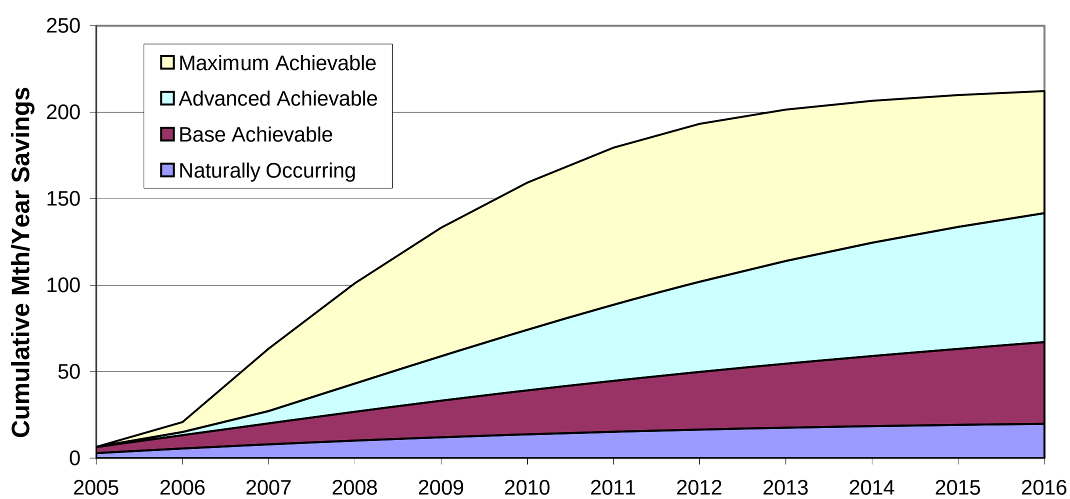
In contrast to technical and economic potential estimates, achievable potential estimates take into account market and other factors that affect adoption of efficiency measures. Our method of estimating measure adoption takes into account market barriers and reflects actual consumer- and business-implicit discount rates. This section presents overall results for achievable potential.

Achievable potential refers to the amount of savings that would occur in response to one or more specific program interventions. Net savings associated with program potential are savings that are projected beyond those that would occur naturally in the absence of any market intervention. Because achievable potential depends on the type and degree of intervention applied, we developed potential estimates under alternative funding scenarios: Base achievable, Advanced achievable, and Maximum achievable.

The Base achievable funding scenario reflects funding levels similar to 2004-2005 program budgets. The Maximum achievable scenario reflects large increases in marketing/information budgets (see Section 2 for details) and an increase of rebates levels to 100 percent of incremental measure costs. The Advanced achievable scenario represents funding levels that are in between the Base and Maximum achievable scenarios. Program energy and peak-demand savings were forecasted under each scenario for the 2005–2016 period. Given limited IOU program experience with industrial natural gas measures, both the Maximum achievable and Advanced achievable scenarios reflect an extension of current program-cost/savings relationships that introduces forecast uncertainties that should be noted in reviewing these results.

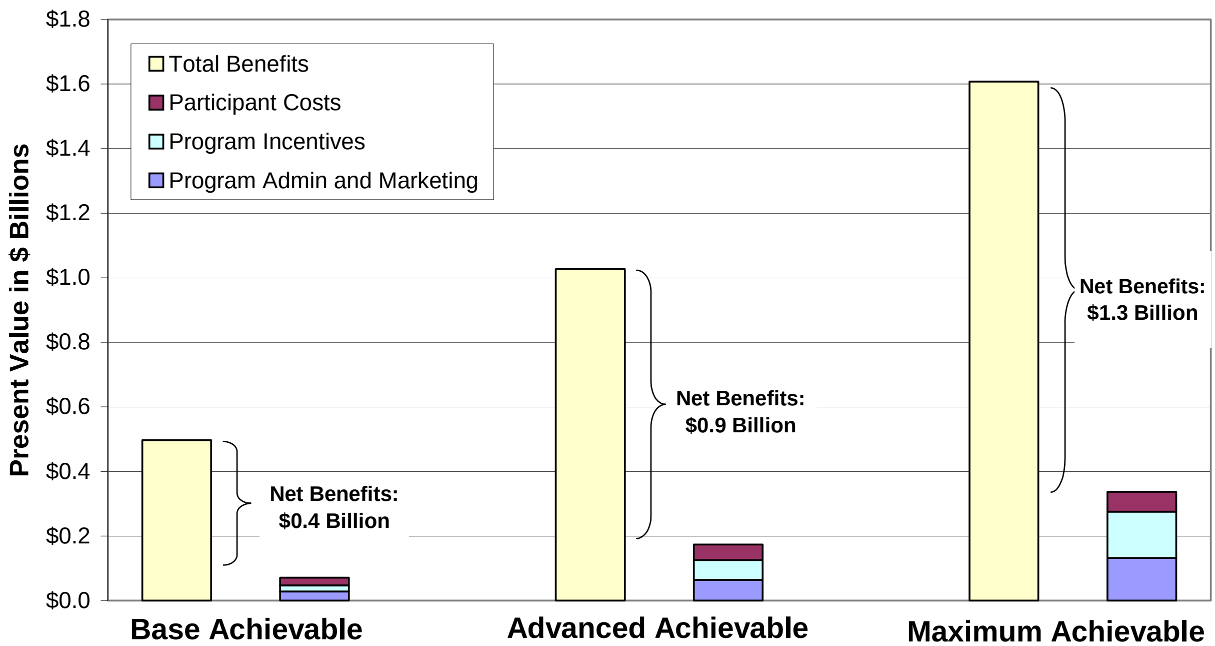
Figure 4-7 shows estimates of achievable potential savings for natural gas. Net energy savings are projected to be roughly 50 Mth under Base achievable, 120 Mth under Advanced achievable, and 190 Mth under Maximum achievable.

Figure 4-7
Achievable Natural Gas Savings Potential by Program Funding Scenario



The costs and benefits associated with the industrial efficiency funding scenarios over the 2005–2016 forecast period are shown in Figure 4-8. Total program and participant costs vary from $0.07 billion under the Base achievable scenario, to $0.3 billion under Maximum achievable scenario. Total avoided-cost benefits range from $0.5 billion under Base achievable to $1.6 billion under Maximum achievable.[1] Net avoided-cost benefits, which are the difference between total avoided-cost benefits and total resource costs (which include participants' costs), range from $0.4 billion to $1.3 billion. All of the funding scenarios are cost effective based on the total resource cost (TRC) test, which is the principal test used in California to determine program cost effectiveness.

Figure 4-8
Costs and Benefits of Industrial Natural Gas Efficiency Savings – 2005 to 2016*



*Value of benefits and costs over life of measures, nominal discount rate = 8 percent, inflation rate = 3 percent.

TRC test and other results are summarized in Table 4-3 for all scenario runs. The results shown indicate that all the scenarios are cost effective based on the TRC. TRC values range from a high of 7.0 under the Base achievable scenario to a low of 4.8 under the Maximum achievable scenario. TRC values tend to decrease somewhat as funding levels increase because savings are acquired from measures that are of decreasing cost effectiveness. That is, under the higher funding levels, energy-efficiency opportunities are being purchased from higher and higher on the energy-efficiency supply curve.

[1] For this study, avoided costs were derived from the Avoided Cost Model developed by Energy and Environmental Economics, Inc. (E3) for the CPUC (E3 2004).

Table 4-3
Summary of Industrial Natural Gas 12-Year Net Program Potential Results*

Result	Base Achievable	Advanced Achievable	Maximum Achievable
Program Costs (Mil.)	$48	$126	$275
Participant Costs (Mil.)	$24	$48	$61
Avoided Cost Benefits (Mil.)	$497	$1,027	$1,608
Net Benefits (Mil.)	$426	$853	$1,271
Net Savings	47 Mth/Yr	122 Mth/Yr	192 Mth/Yr
Program TRC Ratio	7.0	5.9	4.8

*All costs, energy and demand savings are cumulative amounts through year 2016. Program TRC is for the entire 2005-2016 forecast period. Present value of benefits and costs over 20-year normalized measure lives for 12 program years (2005-2016), nominal discount rate = 8 percent, inflation rate = 3 percent.

4.3.1 Breakdown of Achievable Potential

Figure 4-9 shows achievable potential estimates by utility. The results show net cumulative savings estimates through 2016. PG&E shows the highest Base achievable and Advanced achievable savings potential, while SCG is somewhat higher in the Maximum achievable scenario. This result reflects the fact that PG&E's current programs show somewhat higher impacts than SCG's.

Figure 4-9
Industrial Achievable Natural Gas Savings Potential by Utility—Cumulative 2005 to 2016

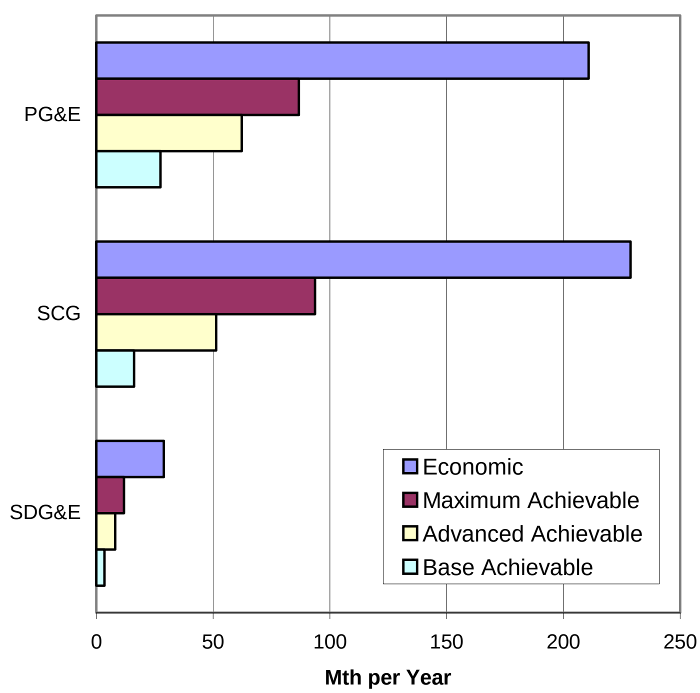
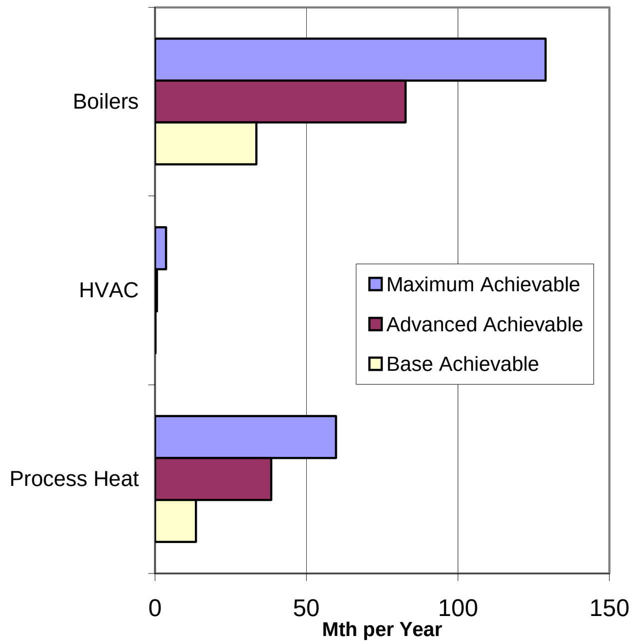


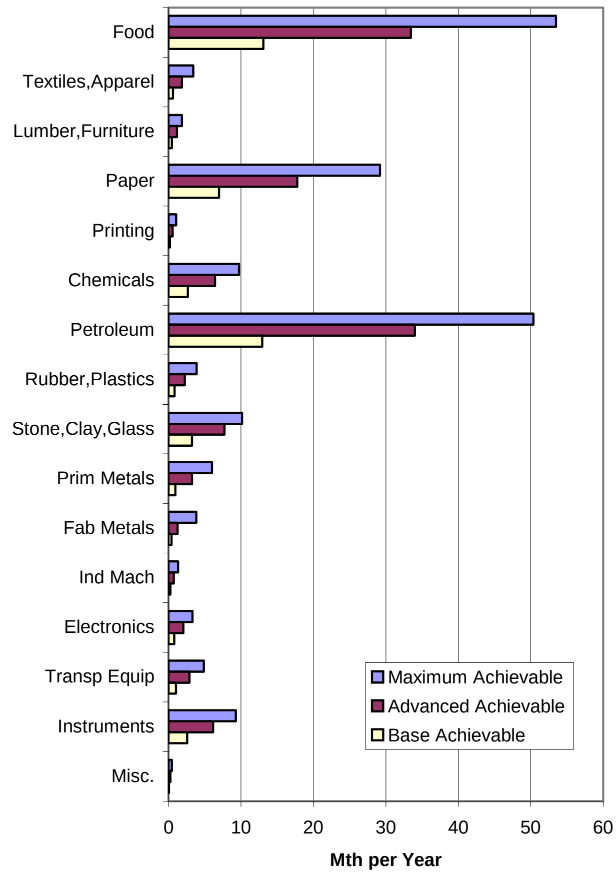
Figure 4-10 shows achievable potential estimates by end use. Boiler systems show the highest potentials, at about twice the level of process heating systems. Boiler systems often include extensive steam and hot water piping networks that can be targeted for savings, while process heating systems do not.

Figure 4-10
Industrial Achievable Natural Savings Potential by End Use—Cumulative 2005 to 2016



Achievable potentials by industry type are shown in Figure 3-14. Food, petroleum, and paper provide the largest sources of potential under all three achievable scenarios.

Figure 4-11
Industrial Achievable Natural Gas Savings Potential by Industry—Cumulative 2005 to 2016



4.3.2 Summary of Potentials

Industrial energy efficiency potential discussed above is summarized in the following tables. Table 4-4 presents natural gas potentials by utility, Table 4-5 presents potentials by end use, and Table 4-6 presents potentials by industry. Additional detail on natural gas potential is presented in Appendix L. This appendix shows technical, economic, and achievable potential by utility, industry segment, and end use.

Table 4-4
Summary of Industrial Natural Gas Potentials by Utility—Cumulative 2005 to 2016

Utility	Total Mth	Mth Potentials*					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
PG&E	1,664	211	211	87	62	27	9
SCG	1,718	229	229	94	51	16	10
SDG&E	209	29	29	12	8	4	1
Total	3,591	469	468	192	122	47	20

* Note, achievable savings are net savings and do not include naturally occurring savings.

Table 4-5
Summary of Industrial Natural Gas Potentials by End Use—Cumulative 2005 to 2016

End Use	Total Mth	Mth Potentials*					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Boilers	1,135	275	275	129	83	33	19
Process Heat	1,293	177	176	60	38	14	1
Other Process Use	61	0	0	0	0	0	0
HVAC	187	17	17	4	1	0	0
Feedstocks	784	0	0	0	0	0	0
Other	131	0	0	0	0	0	0
Total	3,591	469	468	192	122	47	20

* Note, achievable savings are net savings and do not include naturally occurring savings.

Table 4-6
Summary of Industrial Natural Gas Potentials by Industry—Cumulative 2005 to 2016

Industry	Total Mth	Mth Potentials*					
		Technical	Economic	Maximum Achievable	Advanced Achievable	Base Achievable	Naturally Occurring
Food	629	130	130	53	33	13	7
Textiles, Apparel	43	8	8	3	2	1	0
Lumber, Furniture	34	5	5	2	1	0	0
Paper	329	65	65	29	18	7	4
Printing	27	3	3	1	1	0	0
Chemicals	197	24	24	10	6	3	1
Petroleum	1,437	107	107	50	34	13	4
Rubber, Plastics	54	9	9	4	2	1	0
Stone, Clay, Glass	260	38	38	10	8	3	0
Prim Metals	144	20	20	6	3	1	0
Fabricated Metals	99	13	13	4	1	0	0
Industrial Mach	33	4	4	1	1	0	0
Electronics	55	8	8	3	2	1	0
Transportation Equip	84	12	12	5	3	1	0
Instruments	159	23	23	9	6	3	1
Misc.	8	1	1	0	0	0	0
Total	3,591	469	468	192	122	47	20

* Note, achievable savings are net savings and do not include naturally occurring savings.

4.4 SUMMARY AND CONCLUSIONS

For the 2005-2016 period, cumulative achievable natural gas savings in the industrial sector range from 1 to 5 percent of base usage for natural gas (for the Base, Advanced, and Maximum achievable program scenarios, respectively). Similar to the electric results, the achievable program estimates fall below economic potential estimates because it is unlikely that programs will be able to capture all the available savings due to factors such as naturally occurring savings, limited equipment turnover during the forecast period, and the fact that some customers will not install cost-effective measures due to various market barriers (such as capital limitations, lack of information about measures, limited installation opportunities due to production schedules, and hassle).

Cumulative savings for the Maximum achievable forecast are about 300 percent higher than the Base forecast. This spread is much higher than for the electricity projections, reflecting the fact that California has pursued electricity efficiency options more rigorously that it has pursued natural gas options. There is also more uncertainty in the maximum achievable and advanced natural gas forecasts, since they reflect program efforts that are considerably beyond historical experience.

Similar to electricity, improved process controls, system optimization, and operation and maintenance measures are key components of potential natural gas savings. These measures are likely to be more difficult to implement than strict equipment efficiency improvements, as they will require more customer education to effect improvements. A key component of forecast uncertainty is related to customer adoption of the control and optimization measures.

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